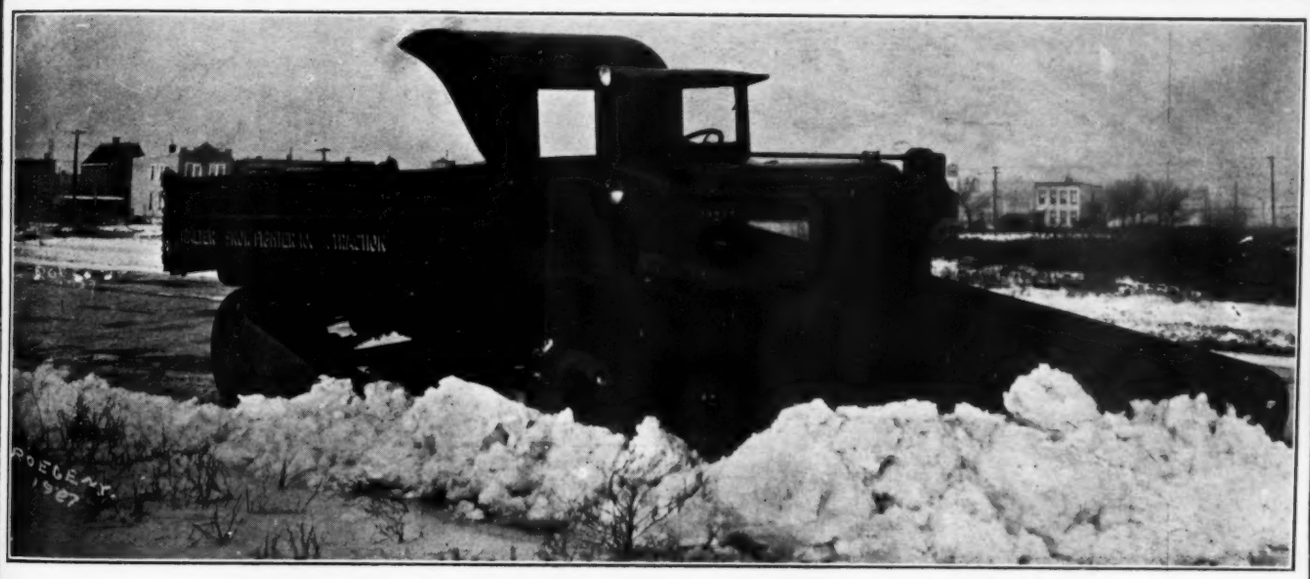
PUBLIC WORKS
COUNTY STATE



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THIS WALTER SNOW FIGHTER is scraping snow. Note that the pavement is absolutely clean and bare. The dense motor traffic packs the freshly fallen snow, and unless this' packed snow is immediately removed, ice ruts are formed which become worse as the winter goes on. These ice ruts cause serious accidents and generally ruin the pavements.

The center scraper of the WALTER SNOW FIGHTER is the only effective way to clear such packed snow.

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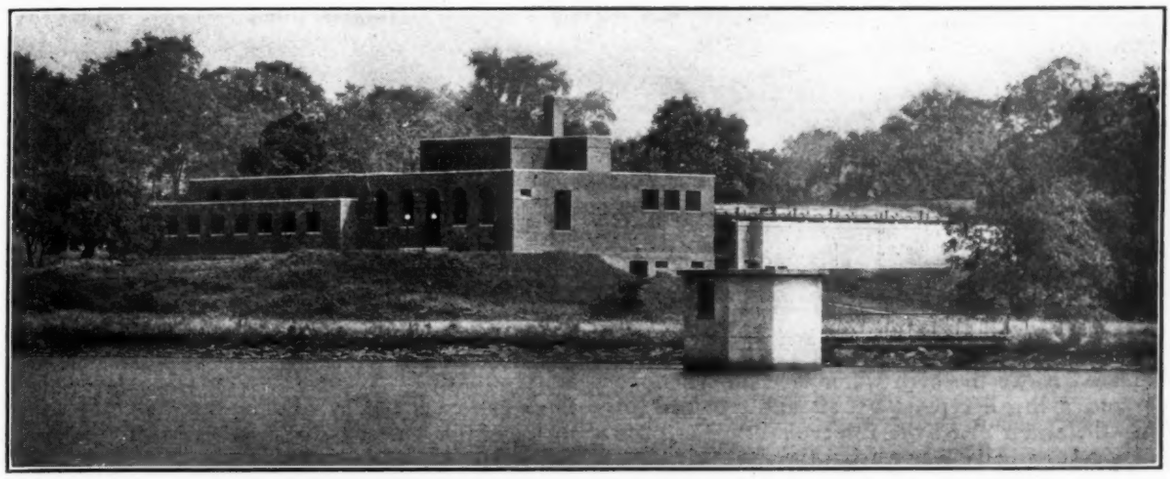
CITY COUNTY STATE

A Combination of "MUNICIPAL JOURNAL" and "CONTRACTING"

Vol. 59 November, 1928 No. 11



GENERAL VIEW OF GREENWICH FILTRATION PLANT

Water Purification at Greenwich

Coagulation basins provided for use in connection with the old pressure filters, and new gravity filters constructed. Water also aerated and chlorinated. Experiment with sand of high uniformity coefficient. Automatic and remote control to minimize supervision. Safe and attractive water secured.

The Greenwich Water Company, a subsidiary of the Community Water Service Company, supplies water for Greenwich, Connecticut, obtaining its supply from two reservoirs known as Putnam and Rockwood lakes, which are connected and have a common tributary water shed of 4.65 square miles, including the area of a small stream, Pipen brook, which is diverted into Rockwood lake. An emergency supply is available by pumping into Rockwood lake from the Mianus river or from the East branch of the Byram river.

The watershed tributary to the two lakes is sparsely inhabited and comparatively free from sources of contamination, although some possibility of pollution exists from the few inhabitants and the highways which traverse it. On the Mianus river, four or five miles above the intake, are two small villages neither of which is severed. The Byram river watershed above the point of diversion is largely cleared land devoted to agriculture with a few houses located well back from the stream, and the sanitary conditions are good.

Putnam lake has a total capacity of 572 million gallons and Rockwood lake a capacity of 500 million gallons, while Pipen brook reservoir has a capacity of 14 million gallons.

The supply is drawn from Putnam lake and until a few months ago was treated in a plant consisting of two automatic-control dry-feed W. and T. chlorinators, and two horizontal pressure filters each 8 feet diameter by 20 feet long, and twelve vertical pressure filters each 10 feet diameter by 10 feet high, the rated capacity of these being about 4,000,000 gallons per day.

This capacity has become inadequate for the present consumption; also there has been some difficulty in securing satisfactory effluents, largely because of the absence of settling basins. It was therefore decided by the water company to increase its filter capacity by the construction of gravity-type rapid-sand filters at Putnam lake.

DESCRIPTION OF NEW PLANT

The new plant, which went into operation last April, consists of a low-lift pumping station, aerators, chemical mixing tanks, coagulation basins, rapid sand filters, clear water basin and chlorination equipment. The coagulation basin has a rated capacity of 6,00,000 gallons per day, the filters of 4,000,000 gallons per day, and the clear water basin has a storage of 1,000,000 gallons. The excess capacity of the coagulation basin was provided to permit its use in conjunction with the existing pressure filters. The plant is so laid out as to be capable of ultimate expansion to 8,000,000 gallons per day.

In order to increase available storage and to provide adequate head after filtration, the filter plant

SPRAY NOZZLES ON TOP OF COAGULATION BASIN

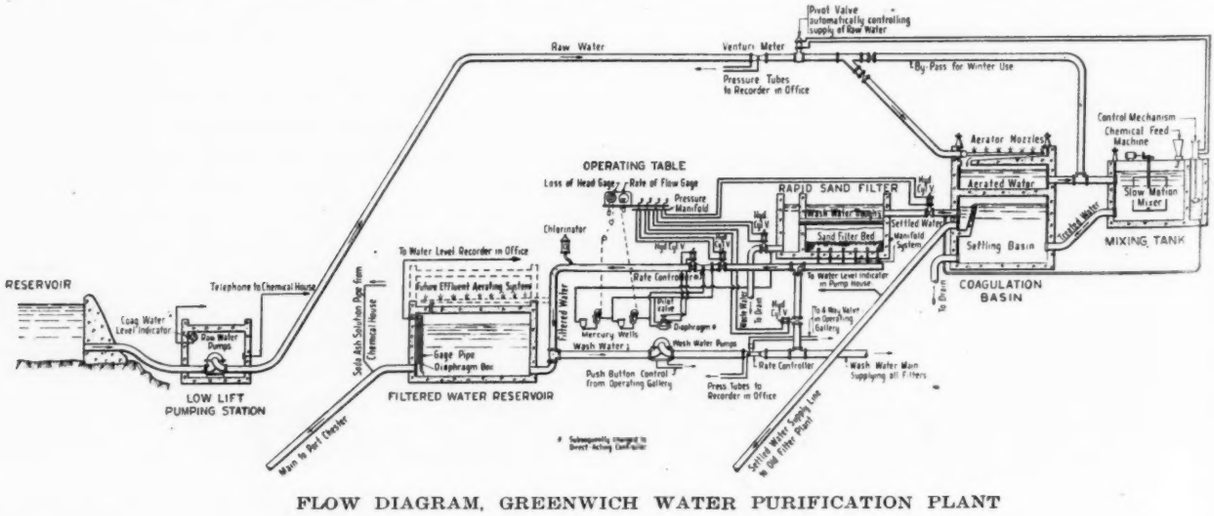
was placed above the high water level in the reservoir, and a low-lift pumping station provided for lifting the water from the reservoir into the plant. These pumps receive water from the reservoir under a gravity head of about 20 feet when the reservoir is full.

The raw water is pumped either to aerating nozzles or to the chemical mixing tanks. Regulation of pumping is secured by means of a butterfly valve in the discharge line, automatically controlled by the water level on the filters. As the water level on the filters rises, the valve closes, thereby increasing the friction head against the pump.

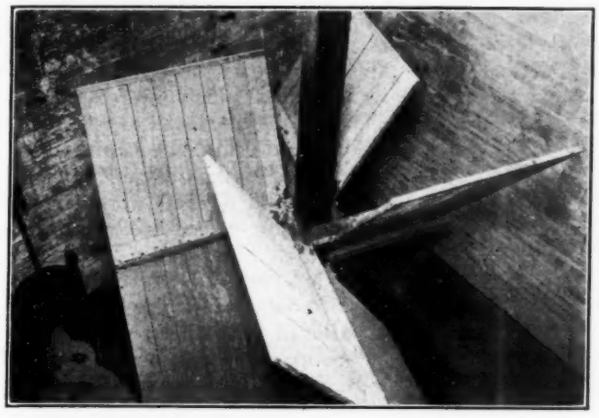
Aeration is provided by 48 Sacramento type nozzles located on the roof of the coagulation tanks. These nozzles are symmetrically placed in six rows of 8 nozzles each in a grid of cast iron pipe raised above the roof on concrete piers. The sprayed water falls upon the roof and drains to a conduit leading to the chemical mixing tanks. The nozzles throw a spray of approximately 17 feet diameter with a nozzle head of about 5 feet. Three sides of the aeration roof are surrounded by a fence of corrugated zinc 7 feet 6 inches high, while on the fourth side are the control valves and walk-way.

There are two chemical mixing tanks in which the aerated water receives the doses of chemicals. In these tanks, which are 18 feet square with a water depth of 17½ feet, adequate mixing is secured by mechanical stirrers consisting of wooden paddles operated by electric motors, which revolve at about 1 revolution per minute. When the plant is operated at 8 m. g. d. the tanks give a total mixing period of approximately 15 minutes. The chemicals (filter alum and soda ash) are applied by means of three motor-operated No. 3 Gauntt dry-feed machines. In the two alum machines a stream of water mixes with and dissolves the chemical and the solution is fed by gravity through rubber hose to the water entering the mixing basin. The soda ash is applied in a similar way to the filtered water as it leaves the filtered water resrvoir, to neutralize the increased acidity produced by the alum. The chemical feed machines have been calibrated and control of chemical application is very accurate. Provision is made for adding soda ash to the raw water if it should become necessary in the future, although generally the raw water contains adequate alkalinity to react with the alum.

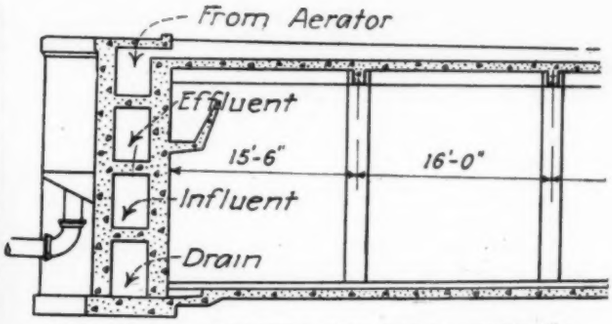
There is a settling basin divided into three compartments by partition walls, each compartment 95 feet long by 33 feet wide, with a central, longitudinal plank baffle around which the treated water flows. The basin is covered with a flat slab roof. One end of the basin consists of a hollow wall three feet wide inside, with horizontal partitions forming conduits about 4 feet deep. The top conduit conveys aerated water to the chemical mixing tanks; the second conveys chemically treated and settled water from the settling tanks to the filters; the third conveys chemically treated water from the



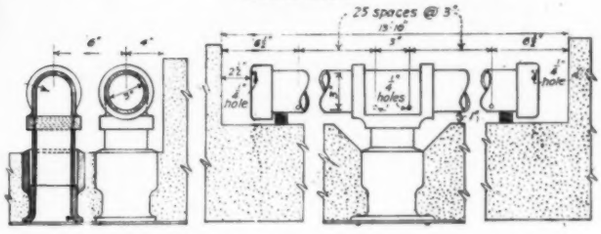
FLOW DIAGRAM, GREENWICH WATER PURIFICATION PLANT



LOOKING DOWN AT MIXING PADDLES



ONE END OF COAGULATION BASIN, SHOWING CONDUITS



DETAILS OF FILTER UNDERDRAIN

mixing tanks to the settling basins; and the bottom one drains the settling basin. Near one end of these channels is a bypass chamber with adjustable weir over which a portion of the chemically treated settled water is discharged to a pipe leading to the old pressure filters. The settling basin gives a theoretical detention of four hours with a flow of 6 m.g.d.

There are eight units of filters (provision has been made for adding 8 more in the future), each unit with a capacity of 0.5 m.g.d. at a rate of filtration equivalent to 125 m.g.d. per acre. Across one end of each filter box is a concrete baffle wall extending from the floor to within 2 feet 7 inches of the top of the box. This wall forms an inlet chamber through which the settled water is applied to the filters and from which washwater is discharged.

The underdrains consists of 3-inch cast-iron pipe laid 6 inches center to center over the filter floor. These pipes are provided with quarter-inch holes on the two lower quadrants, staggered six inches centers. These connect, by means of vertical tees, to a central concrete conduit, from which filtered water passes through a Builders Iron Foundry rate controller to the main effluent pipe leading to the clean water basin.

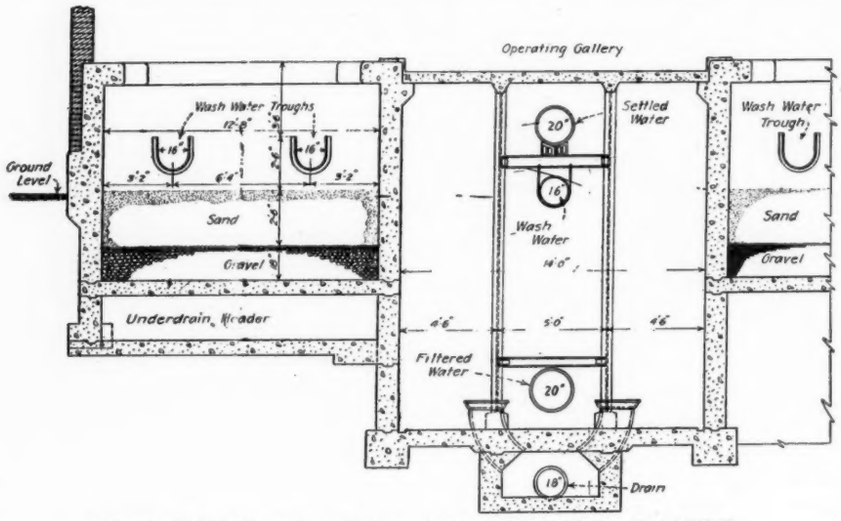
Each filter unit contains two wash-water troughs of steel, 16 inches wide, painted; the tops of the troughs being 2 feet 6 inches above the surface of the sand.

The filter medium consists of 30 inches of sand over 18 inches of graded gravel. The specifications for sand called for an effective size of not less than 0.30 m.m. nor more than 0.40 m.m., and a uniformity coefficient not greater than 1.60. In the case of six filters, Cape May sand was used having an effective size of 0.36 to 0.37 m.m. and a uniformity coefficient of 1.48 to 1.55. In the remaining two filters Cow Bay sand was used having an effective size of 0.37 m.m. and a uniformity coefficient of 4.65. The use of the latter sand was due to the desire to determine on a working scale whether

FILTER BAY, SHOWING RECORDING AND OPERATING TABLES OF THE EIGHT FILTERS

this sand would accomplish satisfactory results, its cost delivered being much less than the Cape May sand.

Wash water from the clear-water basin is provided by two motor-operated, automatically primed, centrifugal pumps discharging directly to the filter underdrains through a 16-inch pipe. These pumps have a capacity of 4 m.g.d. The normal vertical rise of wash water through the filter is 24 inches per minute. The pumps are started and stopped by push button control in the operating gallery.



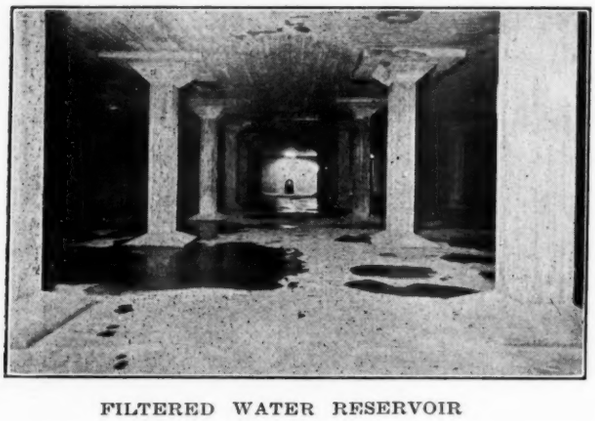
CROSS-SECTION OF FILTER AND OPERATING GALLERY

The clear water basin is 74 feet wide by 150 feet long, with maximum water depth of 14 feet 6 inches. It is covered by a slab roof, the top of which pitches to its perimeter, around which is a low concrete wall so that a secondary aerator for filtered water can be installed if future experience shows the necessity for such installation.

The corner of the basin nearest the filter house is partitioned off, forming a compartment of 17½ feet by 36½ feet, which is divided in halves along its length by a wooden partition. The object of this compartment is to provide contact period for the chlorinated filter effluent before it mixes with the water already stored in the basin.

Chlorine is applied to the filtered water prior to its entrance to the clear water basin by means of two vacuum type Wallace & Tiernan chlorinators.

The pipe gallery is unusually roomy, being 14 feet wide by 16 feet high. The mains are suspended in the center of this, the uppermost being the 20-inch settled water pipe, below this the 16-inch wash water pipe, and below this the 20-inch filtered water pipe. At the bottom is an 18 inch tile drain. A plank walk extends along the gallery just above the filtered water pipe. Sampling cocks are provided on each filter outlet.



FILTERED WATER RESERVOIR

SPECIAL FEATURES

In designing the plant, an attempt has been made to reduce the amount of supervision required in the operation of the various parts. Several automatic and remote control features have been installed for this purpose.

The low-lift pumps are equipped with slip-ring motors which permit of adjustable speed control. Extension relay circuits for the control apparatus have been placed in the office of the chemical house and the speed of the pumps may be controlled from either the chemical house or the low-lift pumping station.

Valves controlling the inlet, outlet, wash water and drain ports of the several filter units operate hydraulically by means of hand levers on the operating tables.

The wash-water pumps may be started and stopped by means of push buttons in the filter wing. There are also telltale lights in the operating gallery to indicate which pump is running. An automatic priming device keeps the pumps primed at all times. and on failure of the priming system throws out the electric circuit so that the pumps can not be started until the priming is complete. Also, a rate controller has been placed on the discharge of the pumps, which automatically holds the rate of washing on the filters constant. An annunciator in the office indicates high and low water in the filtered water reservoir.

Water supply for the laboratory, toilets and operation of hydraulic valves is obtained from small pneumatic pressure tank systems installed in duplicate; the tanks, each of five hundred gallons capacity, being filled by 50 g.p.m. centrifugal pumps drawing water from the clear-water basin.

Regular operation of the plant began the latter part of April, under the general supervision of W. J. Willson, superintendent of the Greenwich Water Company, and under the direct supervision of Harold C. Chandler as chemist in charge. The filter runs between washings were unduly short during the first few weeks. Increasing the rate of washing of the filter to about 30 inches vertical rise per minute and scraping off the top two inches of fine material resulted in an improvement in filter runs. Copper sulphate treatment of Putnam lake also may have been of some value in destroying microscopic organisms which, if reaching the filters in any quantity, would tend to decrease filter runs.

The preliminary treatment of the raw water by

coagulation and settling at the new plant prior to passing it through the old pressure filters has brought about a marked improvement in the quality of the effluent from them.

In applying soda ash to the filtered water, this is not applied directly to the water from the pressure filters, but water from the clear water basin of the new plant that has been so treated flows by the old filter plant in the 30 inch pipe originally carrying raw water to these filters, and is mixed with the effluent from the old pressure filters. By overdosing with soda ash the effluent of the new plant, and by chlorinating it with the chlorine equipment formerly used for chlorinating the pressure filter effluent, the effluent of the pressure filters is corrected for corrosive qualities by the excess soda ash and disinfected by the chlorine carried to the effluent by the new plant. To supply soda ash directly to the pressure filter effluent would require an additional chemical feed machine and ejector equipment; while direct chlorination of the pressure filter effluents would have required further changing of equipment. The results obtained by the present method of operation appear to be satisfactory.

The quantity of water treated by both filter plants has averaged about 3 m.g.d. each, or 6 m.g.d. total. The average length of filter runs for the new plant gradually increased from about 8½ hours in May to 11 hours in August. The pressure filters during this period have required washing but once daily; due probably to the coarser sand in the pressure filters. In general the alum application has been at the rate of 0.9 grain per gallon and the soda ash at 10 p.p.m. The chlorine dose has averaged about 0.5 p.p.m.

OPERATION RESULTS

The combined filter plants have produced a clear, practically colorless and non-corrosive water. Turbidity has been reduced from about 3 p. p. m. to zero, and color from about 25 p.p.m. to 3 p.p.m. The pH of the delivered water has averaged about 7.0. Bacteria have been materially reduced. The average 20°C. gelatine counts per cubic centimeter have been about 500 in the raw water and 2 in the delivered water. The 37°C. agar counts have been reduced from 95 to 2 per cubic centimeter. The raw water usually contains organisms of the B. coli type in 10 c.c. innoculations and occasionally in 1 c.c. At no time has the delivered water given confirmed tests for these organisms.

The new purification works were designed by Metcalf & Eddy, and constructed by Stone & Webster, Inc., with Carlton F. Green as construction superintendent.

The above information is obtained from a paper by E. S. Chase, of Metcalf and Eddy, read before the convention of the New England Water Works Association. At the same convention another paper was read by Dana M. Wood, hydraulic engineer with Stone and Webster, describing quite fully the historical development of the Greenwich Water Company and its existing plants prior to the recent improvement.

Mr. Wood stated that in September, 1925, Stone & Webster, Inc., was asked to examine the properties with a view to purchase by Putnam and Storer, Inc., of Boston, and after acquisition, to continue the investigation to ascertain the immediate construction requirements for serving the existing territory with reasonable provisions for the future, and the possibilities for serving a greatly increased territory perhaps extending from Stamford to New York City.

When the general plans for development had been decided upon, in January, 1927, the firm of Metcalf and Eddy was authorized to proceed with the design of the purification plant. There was some delay in obtaining possession of the land required for the purification plant, but on April 18, notification was received of its purchase and active work started. On August 6, pouring concrete in the filter house began, on September 20 brick laying began, on October 11 authorization was received to construct two additional filters, on October 22 pouring concrete in the pump house was started, and on November 19 the contractors finished the concrete work of the coagulation basins. On February 25, 1928, the second filter extension was authorized, on April 26 the new filter plant was placed in commercial service, and on July 1 the purification plant was completed. On August 18 the last construction men were off the job. The maximum number of men employed on the work in any one day was 235.

We are indebted to Stone & Webster for the photographs and drawings used in illustrating this article.

The construction of the improvements included other interesting features in addition to the purification plant, and some of these will be described in other articles.

Refuse Disposal in England

Synopsis of practices and costs in eighty-one municipalities. Cost of collection and disposal per ton and per capita.

Under the above title we published in PUBLIC WORKS for December, 1927, an article giving a synopsis of the figures obtained by the Ministry of Health of England concerning the amount and cost of collecting and disposing of refuse of English boroughs and urban districts for the year 1925-'26. A few weeks ago the Ministry issued its annual report for 1926-'27, giving returns from 81 county boroughs, 60 other boroughs and 33 urban districts. The Ministry states that last year's returns show a nearer approach to accuracy than those for the previous year. But furnishing returns showing unit cost of street cleaning is still beyond a number of authorities, and "the information received for the cost per 10,000 square yards of streets cleansed has not been such as to warrant its conclusions in the appendices. The most serious source of error is still in estimates of the weight of refuse. Comparative data cannot be used with assurance so long as the weight of refuse is only estimated, at any rate unless the estimate is carefully based on a sufficient foundation of ascertained fact. The particulars are not required just for information. The object of the returns is severely practical. Unless committees and officials know what weight of refuse

is being dealt with they can not confidently know whether value is being obtained for the expediture incurred."

The cost figures include loan or depreciation charges and expenditures for new plant out of revenue; and the income, if any, has been deducted.

Considering first the average weight of refuse per thousand of population per day, the reports show that this amount to 37,800 pounds for cities of under 50,000 population; 33,400 pounds for those between 50,000 and 100,000; 30,200 pounds for those between 100,000 and 200,000; and 31,400 pounds for 200,000 and over; an average for all the 167 places making returns of 34,000 pounds. The average costs per ton of collection are given as follows: For places under 50,000 population, $2.04; for those between 50,000 and 100,000, $2.20. For those between 100,000 and 200,000, $2.18; for those over 200,000, $2.42; an average for all places of $2.12.

The average costs per ton of disposal are given as follows: For places under 50,000 population, 93c; for those between 50,000 and 100,000, 99c; for those between 100,000 and 200,000, $1.23; and for 200,000 and over, $1.09; an average for all places of $1.

The loan and depreciation charges and expenditures for new plant average twenty-four cents.

The average costs of collection and disposal per thousand population were as follows: Cost of collection for places under 50,000 population, $595; for those between 50,000 and 100,000, $653; between 100,000 and 200,000, $566; and for those over 200,000, $673; an average for the 160 places reporting of $620.

The average costs of disposal per thousand population was: For places under 50,000 population, $261; between 50,000 and 100,000, $237; between 100,000 and 200,000, $295; over 200,000, $305; an average for the 160 places reporting of $271.

Fourteen places reported the total cost of both collecting and disposal but not that of each separately, these comprising eight places of the smallest size, four of the next largest size, and two of the next group. The average cost of both service for the total 174 places was: For places under 50,000, $842; for those between 50,000 and 100,000, $886; between 100,000 and 200,000, $862; over 200,000, $978; an average for all 174 places of $876.

The costs of individual places varied quite widely. Those for collection varied from $340 to $1,000 per 1,000 population per year; and from $1.45 to $4.48 per ton; although 80 per cent were under $775 per 1,000 population or $2.66 per ton.

Rye Beach Sewage Treatment Plant

From old plant, displaced by amusement park, sewage pumped over a ridge to fine screens and chlorinated effluent pumped back to new outlet. Sewer laid in soft mud and rock tunnel.

By D. J. Shaw*

Rye Beach, in Westchester county, N. Y., with an amusement park privately owned and operated, has been the principal playground for the people of that county for over a quarter of a century. A few years ago the county organized a park commission and under its direction has built many extensive parks and boulevards, and during the past year has built a new and elaborate playground known as "Playland" on and adjoining the site of the old Rye Beach Park, which it superseded.

The incorporated village of Rye, in which the new park is situated, has had for a number of years a complete sewer system and a disposal plant consisting of settling tanks, pumps and trickling filters. This plant had always worked satisfactorily up to the time of its discontinuance at the end of the year 1927.

This old disposal plant was almost in the exact center of the area on which the new park is laid out. In fact, the newly made artificial lake in the park has flooded a portion of the site occupied by the old disposal plant. It was accordingly decided to remove the point of sewage disposal to a position outside and distant from the new park.

This work devolved on a separate commission which has charge of all county sewers, the Westchester County Sanitary Sewer Commission, with headquarters in White Plains, N. Y. The commission consists of Francis A. Stratton, Ralph L. Crow and Henry H. Law. Eugene Martin is executive secretary and Wm. W. Young is chief engineer.

The decision to replace the sewage disposal plant was made in the summer of 1927, as the plans for the proposed park developed, and plans were rushed and the work given out to contract in September, 1927. The Shevlin Engineering Co. of New York was the contractor on the land portion of the work at a bid price of $385,000. The underwater outfall was laid by the Merritt Chapman Co. of New York under a separate contract, their bid price being $240,000.

The opening date of the park was set for Memorial Day, 1928, and the completion of the new sewer and disposal system was set for the same date. The sewerage system of the village had been constructed to drain to the old treatment plant, so it was decided to make no disturbance of the old collecting system but to install, at the old site, a new pumping station which would receive the sewage and pump it to the new site about a mile away and in a different and outlying section of the village.

This plan also had the advantage of economically taking care of all sewage from the new Playland.

The village of Rye is situated on a broad, low ridge having an elevation of about 50 feet, and running east and west between Long Island sound on the south and Blind Brook on the north.

The new layout is as follows:

1. The sewage from the old village sewers and

*Vice-President, Shevlin Engineering Co.

the new Playland flows by gravity to the site of the old disposal works, shown in Fig. 1.

2. The new pumping station automatically pumps this sewage through a new 18 inch C.I. force main to the top of the ridge in the village.

3. From there it flows by gravity through a new 18 inch vitrified tile sewer to a point about 700 feet from the new disposal plant, where it empties into a new 36 inch C.I. line which passes under Blind Brook and extends to the new plant, where it is at elevation —4.00.

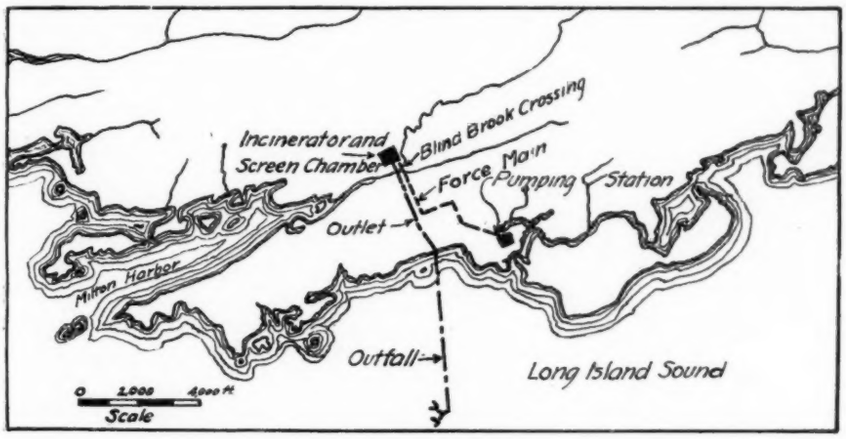


FIG. 1. GENERAL MAP OF RYE, SHOWING OLD AND NEW TREATMENT PLANTS, FORCE MAIN AND OUTFALL

4. Additional sewage from newly developed portions of Rye is collected by a separate sewer system and also empties into this 36-inch influent sewer.

5. In the disposal plant, shown in Fig. 1, the sewage passes first through grit basins and coarse bar screens and then by gravity through two 12-foot disc screens of the Riensch-Wurl type, with slots $\frac{1}{16}$ inch wide. These screens are modified from the original German design to meet American conditions and to withstand more severe operating conditions than the Riensch-Wurl type of screen formerly installed. For the delicate parts of the German designed screens there have been substituted parts constructed in accordance with standard American structural practice, using regular standard structural shapes. These screens have been so designed that the maximum load that can be placed on them, by either accident or design, will produce a maximum stress of 8000 pounds per square inch in the members. The screen has unusual strength and ruggedness, but experience in the large installations in Queens Boro, N. Y., has shown it to be necessary. The screens at Rye, except that they are 12 feet in diameter, are almost exact duplicates of the large 26-foot screens installed by the same contractor in Brooklyn, N. Y., where the worst possible conditions did occur, without damage or even delay.

6. The effluent from the fine screens is automatically chlorinated by three Wallace and Tiernan machines, the mixing being effected by the downward plunge of the chlorinated screened effluent into the storage well below and by passage through the pumps. Detention is partly in the storage well and partly in the long 30 inch force main and outfall.

7. After chlorination, the effluent is pumped by three Fairbanks Morse Wood Trash non-clogging pumps through a 30 inch C.I. force main over the ridge to a point where it flows by gravity through a 30 inch C. I. pipe down the seaboard side of the ridge and thence through a submerged 30 inch C.I. outfall laid in the bottom of Long Island Sound a distance of 6100 feet and discharges into a depth of 40 feet as shown in Fig. 1. Multiple outlets will be provided at some future date, but for the present the discharge is at a single point only.

At the park, the old settling basin was converted into a receiving well. The new pumping plant is built in a concrete structure at a distance of 120 feet from the receiving well, which structure forms part of the foundation of the new park boathouse. Floats in the well operate automatic electric controls for the pumps. The electric wires from Sundh float switches are laid in a lead-covered cable inside an underground galvanized conduit leading from the well to the pumping station.

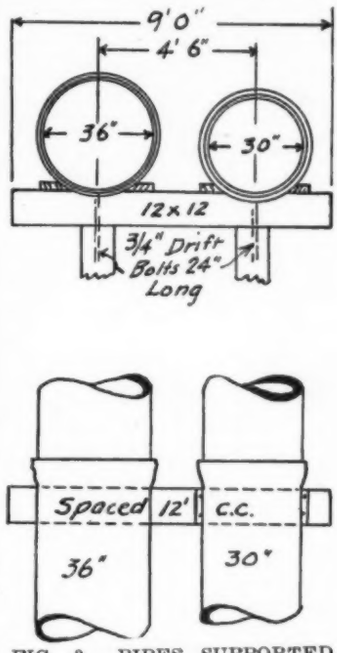


FIG. 2. PIPES SUPPORTED ON PILES IN SOFT GROUND

Two of the pumps are 6-inch to pass a 5-inch sphere, and one is a 4-inch to pass a 3-inch sphere. They are horizontal centrifugal and the motors are therefore some distance below high-water level. To protect against possible flooding of the motors as well as to care for ordinary drainage, wash water, etc., the pump room drains to a small corner sump in which is mounted a vertical 3-inch Fairbanks Morse centrifugal pump with the motor high up in the well and operated by a Sundh automatic float and switch.

The suction line is 20 inch flanged cast iron, with valves and with a 6 inch flanged branch to the low point in the well so that any sediment which is not removed in ordinary operation can be pumped out by closing the 20 inch valve and opening the 6 inch branch. All pumps use the common suction, with individual valves for each pump.

The discharge is 18 inch C.I. bell and spigot, with poured lead joints, passing out under the park and through the streets of the village to the disposal plant. This discharge pipe was subjected to a 40 pound air no-leakage test before acceptance. Across the park property this pipe is laid with a 6-foot depth of cover, resting on piles driven to the under-

lying rock through the fill, which was placed by hydraulic dredges. The depth to rock varies from ten to twenty-five feet. These piles were driven by drop hammer, in bents, in advance of the pipe laying. The fill was a sea mud which dried very slowly, so that at the time of building the sewer the excavated material had to be bailed out of the trench rather than shovelled. This made the trench work difficult, as the t. & g. sheet piling at times floated up, the soft mud being actually in a liquid condition. This condition extended for a distance of 1200 feet, but the contractor did not adopt any special means to combat it—just plugged it along, a short distance at a time. After the pipe was in place and strapped to the piles, there was no further serious difficulty.

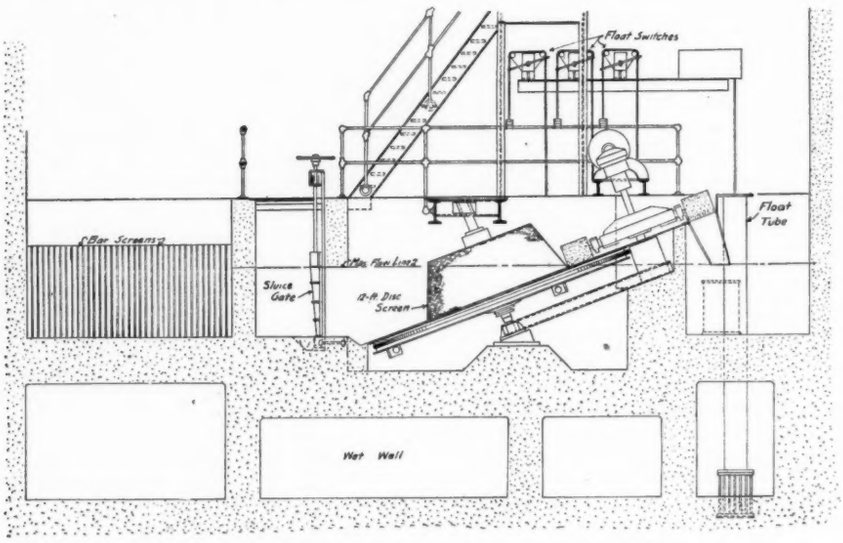


FIG. 3. DISC SCREEN AND SCREEN HOUSE

The 36 inch C.I. pipe was carried under Blind Brook, which at that point is tide water about 40 feet wide by 8 feet deep, by cofferdamming first one half and then the other.

From the brook the pipe passes through a hard-rock tunnel a distance of 500 feet direct into the screening plant. The pipe was laid on the bottom of this 8-foot tunnel and covered with 2 feet of soft earth, the rest of the tunnel being left open. The 30 inch discharge from the screening plant lies alongside the 36 inch through the tunnel and across the brook, as the two follow the same route for some distance.

The screening plant is immediately alongside the Rye village garbage incinerator, and an electric trolley hoist provides for transporting the sewage screenings to the charging floor of the incinerator. The screenings are burned with the garbage and rubbish, no special precautions being taken, and no nuisance has resulted.

Both plants, although they are a mile apart, are operated by one man on each eight-hour shift. The pumps are automatic in both plants, and the screens are left running continuously. The man on duty puts in most of his time at the screening plant but makes two or three visits per shift to the pumping plant. The full crew is 4 men, consisting of the 3 men who work the shifts, while the 4th man is in charge and "spells" each of the three men for one day each week, so that each gets a day off. He also takes his own day off. The pumping plant was placed in operation in April and the screening plant in May of this year.

No meter has yet been placed in the plant so that the exact amount of sewage treated is not known definitely as yet. It is estimated to vary from three to five M.G.D. being contributed by the 20,000 summer residents of the village and the 60,000 to 90,000 visitors to the park, in addition to the all-the-year population.

The park has been a tremendous success from the first day and enormous crowds have attended. As many as 7,500 automobiles have been parked in the official (paid) parking place during a single day, not all at once, however.

When it was realized what great crowds were coming to the park, some concern was felt as to wheather adequate facilities for handling the resulting sewage had been provided. There has been no trouble, however, as the peak load so far encountered has not reached 20% of the plant capacity. The screens have a guaranteed capacity of 6 M.G.D. each, but have a much greater actual capacity with that class of sewage, as the greatest flow to date has not risen to 1/3 of the available screen area of one screen at submergence. They are operated with one in service at a time, with the other as a standby, alternating weekly.

The force mains and outfall have been made

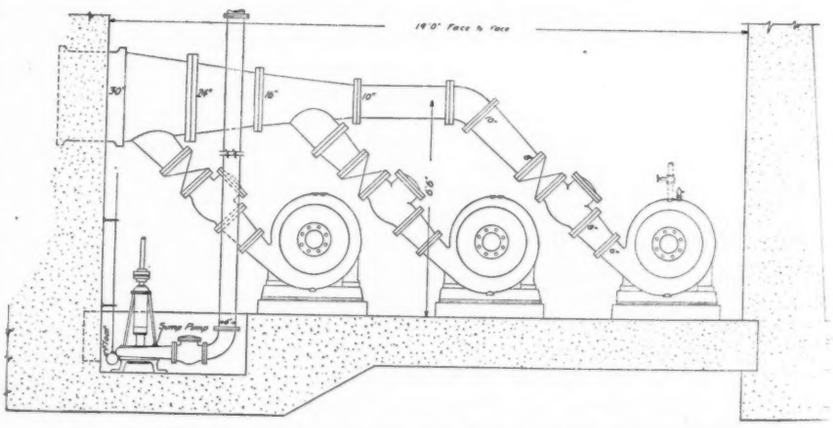


FIG. 4. PUMP LAYOUT. SHOWING DISCHARGE CONNECTIONS

amply large to care for any reasonably possible demand for many years in the future, and the pumping and screening plants, while capable of handling the expected increase for a considerable number of years, are readily susceptible of expansion to any desired degree. At the screening plant there is land available and properly located and situated to permit additional sewage purification and processes of any kind and to any desired degree. It would therefore appear that the Westchester County Sanitary Sewer Commission has designed wisely and well for the future development of the county.

Activated Sludge For Treating Corn Products Waste

About 40 per cent of the dry weather sewage of Decatur, Ill., is waste from a corn products factory. This waste contains a large amount of soluble and colloidal matter, 25 to 50 parts per million of sulphur dioxide, and has a temperature of 100° F. The population equivalent of this waste as calculated from a 5-day B. O. D. averages from 250,000 to 300,000, or five times the actual population.

Effort had been made to treat the total sewage in a plant consisting of grit chambers, Imhoff tanks and three acres of sprinkling filters; but it was found that the filter acreage would have to be increased three or four times to handle the sewage as delivered. To avoid the expense of this, a test was made of the use of activated sludge for reducing the B. O. D. and thereby increasing the capacity of the filter. A testing station was operated for a period of 13 months, using a Simplex aerator for treating settled sewage from the Imhoff tanks. The aeration period was varied from 2.5 to 11.2 hours, the sedimentation period from 1 to 4½ hours, and the filter rate from 1.24 to 5.00 million gallons per acre per day.

Experience with this plant showed that not more than 10% by volume of the sludge, after 1 hour settling, should be kept in the aeration liquor; and that partial aeration in the presence of the pseudo-activated sludge that is formed removes a considerable amount of B. O. D. and breaks down the remaining soluble and colloidal organic matters so that the rate of application to the filters may be tripled or quadrupled according to the length of the aeration period.

Based on these experiments, an aeration plant was built consisting of six aeration tanks of the Manchester type and two 76-foot Dorr clarifiers, with a sludge pump house and blower house. The capacity of the plant is 10,000,000 gallons per day, with an aeration period of 2.5 hours and a sludge settling period of 2.6 hours, and the capacity of the entire plant has been increased from a population equivalent of 60,000 to one of 150,000.

Notes on Practical Sludge Digestion

Application of theory to operating problems in connection with Imhoff tanks and separate digestion tanks. Temperature of sludge. Gas utilization.

By John R. Downes*

To the minds of many it is a far cry from the laboratory work of the scientist in an experiment station to the practical work of the operator in digesting sludge.

Since the writer has been engaged in practical operation for the past fifteen years and has been connected with the New Jersey Experiment Station since its inception and has instigated many of its activities for the definite purpose of throwing light on specific practical problems with which he has come into contact, it may be of some benefit for him to touch on a few operating problems, the solution of which have been more or less affected by the laboratory work.

It is not so simple as might at first appear, to treat the subject of sludge digestion apart from other phases of sewage treatment plant operation. Interrelated therewith are such matters as:

(1) The effectiveness of the settling tanks from which the solids are collected, since this affects not only the quantity but also the quality of the solids to be digested.

(2) The effectiveness of the provisions for removing the solids from the settling tank to the digestion tank, since this affects the reaction of the material.

(3) The adequacy of provision for ultimate disposal of the digested sludge, since, no matter how rapidly the sludge is digested, it will continue to occupy space until removed from the digestion tank.

To illustrate the effect of the completeness of sedimentation, take the manipulation of the same tanks on the same sewage to give varying settling efficiencies, in an actual case under the observation of the writer:

	With Settling Tank of High Efficiency	Low Efficiency
P.P.M. settleable solids in raw sewage..	159	156
P.P.M. settleable solids in settled sewage	55	71
P.P.M. settleable solids retained.....	104	85
Pounds of solids retained by settling tanks	3,453	2,822
Cubic feet 95% sludge to be digested per day*	1,114	910
Minimum cubic feet sludge space required at 70 degrees F. for good digestion....	55,000	45,000

The actual difference is even greater than here indicated, because the solids which escape the low-efficiency tank and are retained by the high-efficiency tank are lighter and highly organic as compared with the quickly settling, gritty, mineral solids, which alone are retained by a tank of low efficiency.

As to the effectiveness of the removal of settled solids from the settling tanks to the digestion tanks, it may be said roughly that every hour of delay in getting the freshly deposited solids from the sedi-

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*From 40,000 persons.

mentation tank to the digestion tank may be counted as a day in so far as the effect on lengthening the period of digestion is concerned. This is because the rapid production of organic acid in the first stages of digestion produces self-poisoning and brings the process to a temporary stop unless the material is promptly added to a large volume of older sludge which is producing sufficient alkali to neutralize the acid (or the acid is otherwise neutralized).

As to the third phase, "Adequacy of provision for ultimate disposal of the ripe sludge." It is quite obvious that this sludge will continue to occupy space in the digestion tank until removed and that, therefore, any lack of facilities for sludge removal will result in a demand for larger digestion capacity or storage space.

To have an excess of digestion capacity is simply to be on the safe side; but unless this excess is very great, the strictest routine of daily additions and withdrawals of sludge must be adhered to in order to keep the process in balance. Therefore, adequate provision for daily withdrawal of sludge must be made; not because it is helpful to remove the ripe sludge, but because (reverting back to the second phase) it is necessary to make room for the daily dose of fresh solids so promptly that they shall not have developed an excess of acid. For this acid will slow up the process of digestion unless (A) the mass of old ripe sludge is great enough to neutralize such acid or (B) it is neutralized with alkali (lime).

In the past, lack of information on this matter has led to indifferent or poor results with separate digestion. In one notable case where large tanks were filled with green solids and left to themselves, no appreciable digestion beyond the very odorous acid stage had taken place in two years' time; whereas, with proper attention to these details of "balance," the digestion time is 40 days or less.

In the case of new works, it is the problem of the engineer to strike the most economical balance between digestion space and provision for removing the ripe sludge; but for the operator, it is generally a case of making the best of what he has. With a thorough understanding of the principles involved and with careful attention to their application, he may make a very limited digestion capacity work satisfactorily.

Imhoff Tanks.—Combination settling and digestion tanks such as Imhoff tanks are very difficult to reason with because of their inflexibility. Any disturbance in the mass of digesting sludge makes itself manifest by an increase in volume of sludge due to increased volume of gas. The only escape for the increased volume of material is into the settling sewage, either through the slots or over the top of the vent walls. If the old and new sludge in the digestion compartment are fairly well distributed and mixed, and not of a viscous nature, excessive activity will be manifest simply by the evolvement of large quantities of gas. If the mixture is not fairly uniform (for instance, when low inlet velocities permit piling up of solids at the inlet end), violent eruptions of gas and entraining solids will occur at intervals.

When such tanks have a very limited digestion capacity, constant vigilance on the part of the operator will be required to prevent trouble. Daily tests of the reaction of the sludge, with immediate correction of any tendency toward acidity, will be necessary to get the most out of the available capacity. Manipulation, with possible baffling of the sedimentation compartment to give maximum distribution of the setting solids throughout the length of the tank, will be helpful.

It is not the purpose of this paper to go into details, but in answer to a question often repeated it may be said that the only way to secure the proper effect of the lime as a neutralizing agent in these combination tanks is to pump the sludge to the surface with a circulating pump and introduce the lime into the returning sludge as it falls from a trough to the surface of the gas vents.

Separate Digestion Tanks.—In the case of separate digestion tanks, the same fundamental phenomena occur under the same provocation. Work with digestion of sludge in separate tanks provided with floating covers has given the writer considerable insight into the happenings of the digestion period. Just as he has observed that in Imhoff tanks a sudden barometric change in the atmosphere results in instantaneous violent eruptions in the gas vents; so he has observed that the floating covers will rise or fall several inches in a very short time under the same conditons. Very recently in a tank 20 feet deep with a surface area of 1200 sq. ft. a drop in the barometer caused the cover to rise four inches during the 30-minute noon period. This equals an expansion of 400 cu. ft. in approximately 20,000 cu. ft. of sludge in a very few minutes.

In the case of the floating cover, this was merely a very interesting demonstration of a natural phenomenon. In the case of an Imhoff tank with narrow gas vents, the operator would have been put to considerable inconvenience by way of cleaning up his settling compartments. With sealed-on concrete covers on a separate digestion tank, the gas catcher would more than likely become choked and the operator would have been surprised to find his automatic overflow giving an increased and murky discharge.

Effect of Temperature.—It is an accepted law of biology that biological activity increases in definite relation to the temperature. This holds for specific groups of organisms in specific ranges of temperature. It is obvious that in dealing with sewage where various groups of organisms are concerned, a comparatively slight alteration of temperature may bring the mass to the optimum for a given group, resulting in rather violent activity. Such a case has been observed by the writer in a change from 69 F. to 72 F. This observation points out the advisability of keeping the mass at a constant temperature where temperature control is practiced, rather than allowing variations over even a narrow range.

In the particular case cited above, the temperature had reached 72 degs. for the first time over a considerable period of time, and the activity was very violent due to the large quantity of food material held in reserve by the lower temperature and suddenly released or made available by the bringing of the mass to the specific optimum for a particular group of gas formers.

This observation brings to mind a proposal for storing green solids in the cold during the winter and digesting them in the summer when the resultant gas would be required for the operation of an actvated sludge plant. To meet such a situation, it would be necessary to store the solids in a container large enough to hold the entire winter production and deep enough in the ground to insure a temperature below say 67 degs. F. until such time as the material should be required for fuel, and to provide for the disposal of the disagreeable, garbage-like odor of the green sludge. In the summer, when gas is needed for fuel, it would be necessary to bring into contact with old, ripe sludge at optimum temperature, such portions of the solids, day by day, as would yield the required volume of gas. At the present time, it would appear that the cost of carrying charges on the storage space and the cost of neutralizing the green solids after storage would be excessive. The analysis of this proposition is given simply as an illustration of some of the principles involved in sludge digestion.

Gas Utilization.—Utilization of the gases of decomposition generated during the digestion of sludge is a progressive step which an operator may often take with nominal outlay; an outlay quickly repaid in the value of the gases reclaimed. Not only is the gas valuable as fuel for heat or power, but the improvement in odor condition is remarkable.

Floating material, partially dried, is a prolific source of odors. If such material is fully submerged, as when it is suppressed by the weight of a floating cover, the more odoriferous compounds are not produced, and, because the process is entirely anaerobic, it proceeds much faster than where there is a conflict between the "anaerobes" and the "aerobes," the former favored by conditions beneath the liquid and the latter by conditions above the liquid.

Collection of the gas and submergence of the floating material are accomplished by the same means; and, fortunately, a cake of grease forms on the underside of the cover used for these two purposes and provides good insulation from cold, so that it is easy to take advantage of the higher speed of digestion which investigation has shown to be possible at higher temperatures.

Heating Sludge.—There seems to be very little information available on heating large masses of sludge. During digestion of sludge in an earth tank of 25,000 cu. ft. capacity, the writer caused hot water at various temperatures to circulate at various rates through a coil of black iron pipe submerged in the sludge. With short, well insulated connections between tank and boiler, the process is regenerative and neither temperature of hot water nor speed of circulation are critical. With 54 sq. ft. of coil surface and the sludge at a temperature of 58 to 60 F., and circulating period of 9 to 10 mins., hot water at 125° yielded up 32° to the sludge; at 115° it yielded 28° and at 100° it yielded 24°. Much has been said of the insulating effect of solids caked on a coil by heat. I know of no demonstration of thats effect and believed that it will not be produced with hot water temperatures below 140° F.

Odor Control at Haddonfield Sewage Plant

Plant units responsible for odors. Treatment for hydrogen sulphide by means of either liquid chlorine or iron sulphate was found successful.

In 1921 a considerable part of the sewage of Haddonfield, N. J., with a population of 5,500, was turned into a new sewage treatment plant known as the Cuthbert Road plant and consisting of an Imhoff tank with two flowing-through compartments, a dosing tank, sprinkling filter, secondary settling basins, and sludge drying beds.

Recently there has been considerable building in the vicinity of the plant, the residences being of a high class; and there have been numerous complaints by nearby residents and a local civic association of highly offensive odors arising from the plant, which prevented a more rapid development of that area and caused the present residents to keep windows and doors closed at all times. Because of this, the State Department of Health began an investigation on October 13, 1927, and continued it intermittently until November 16. This had a three-fold purpose: To determine the capacities and operating efficiency of the plant; to determine, if possible, what units of the plant were responsible for the complaints; and to devise, if possible, some method for the control and elimination of odors by chemical treatment. A condensed report on the second and third points was prepared by Leroy Forman, of the Bureau of Engineering of the State Department, and published in the September issue of the department's monthly bulletin, from which the following is derived.

UNITS RESPONSIBLE FOR COMPLAINTS

It was found that odors were arising at the following places: (1) an open conduit in which raw sewage enters the plant; (2) grease, scum, and other floating material on the surface of the tank and flowing-through compartments; (3) tank effluent; (4) dosing tank; (5) sprinkling filters; (6) secondary setling tanks; (7) gas vents; (8) sludge beds.

(1) The raw sewage enters the plant in a comparatively fresh condition. It has a slight unpleasant but characteristic raw sewage odor. Hydrogen sulphide is present in very small quantities. It is believed that this odor is not objectionable, as the distance of travel is only about 25 feet to the inlet of the tank and the velocity of the flow is great.

(2) The grease, scum, and other floating materials on the surface of the tank produce a rancid, acrid odor, which could be overcome by frequent skimming.

(3) In the tank favorable conditions are provided; i. e., large numbers of sulphur-splitting bacteria, length of contact, and for nearly six months of the year a temperature more or less favorable

for bacterial activity. Sulphates are present in the liquid portion of the sewage to the extent of 36 parts per million of sulphate (SO_4) radical. Here, then, are all the essentials for the formation of hydrogen sulphide, and it is in the tank that nearly all of it is produced.

(4) The dosing tank recovers the effluent from the tank and periodically discharges it to the sprinkling filter. Therefore the same odor prevails here as in the tank.

(5) The tank effluent containing the hydrogen sulphite in solution, after being collected in the dosing tank, is sprayed over the sprinkling filter. This spraying liberates practically all the hydrogen sulphite into the air, so that during and just after the spraying strong odors are present. If the humidity is high and the velocity of the air is low, there is little diffusion, and the offensive odors travel in waves and have been detected for more than a half mile. Even under average atmospheric conditions they can be detected for a distance equivalent to several city blocks. It is believed that one part of hydrogen sulphide gas can be detected in eight to ten million parts of air.

(6) The sprinkling filter effluent contains only a few tenths of a part per million of hydrogen sulphide. It passes into the secondary settling basins, where it has a detention period of approximately one hour. During this time small quatities of hydrogen sulphide are formed but not in sufficient quantities to cause a nuisance.

(7) The gas vents, the part of the scum chambers extending to the top of the tanks, are also sources of offensive odors. They generally contain a more or less thick mass over the surface of the liquid. Gas formation takes place under this mass, and the mass prevents its free escape. Then when the mass is broken up by the operator each day, great quantities of gases containing considerable hydrogen sulphide are given off.

(8) In addition, odors arise during the first few days after sludge is drawn, particularly if the sludge is not completely digested.

At Haddonfield, and in general, odors at sewage treatment plants are more noticeable in the late afternoon and at night than at any other time of the entire twenty-four hours. Hourly tests for the hydrogen sulphide content of the raw sewage and the tank effluent showed that up to three o'clock in the afternoon it was quite low but variable. From 3 P. M. until 8 P. M. the increase was very rapid in the tank effluent, and from 8 P. M. until 1 A. M. it remained very high and uniform. During this entire time the hydrogen sulphide content of the raw sewage was very low, reaching nearly zero. Beginning about 1 A. M. the hydrogen sulphide in the tank effluent dropped rapidly and by 3 A. M. it ha dreached only a few tenths of a part per million and remained low until around 3 P. M. again.

As an example of how much hydrogen sulphide there would be in the air over a sprinkling filter after a discharge, let us assume that a tank effluent contains 10 parts per million of the gas. With a million gallons per day flow and a spray discharge every fifteen minutes, there would be nearly 10,000 gallons to each discharge. Ten parts per million of 10,000 gallons is equivalent to five-sixths of a pound. If one liter of hydrogen sulphide gas weighs 1.4 grams, then there would be 275 liters of gas in five-sixths of a pound, and 275 liters is equivalent to 10 cubic feet. Therefore, for every hour that the tank effluent contains 10 parts per million of hydrogen sulphide there is liberated 40 cubic feet of this foul-smelling gas.

METHOD OF TREATMENT FOR HYDROGEN SULPHIDE

Two methods for treating the sewage for the elimination of hydrogen sulphide were tried, one by adding a chemical that would either kill or inhibit the bacteria that are responsible for its formation, and the other by adding a chemical that would combine with the hydrogen sulphide as it is formed to produce a sulphide salt. Both of these methods proved successful at Haddonfield.

Liquid chlorine was the chemical used in the first experiment, and the experimental work was conducted along lines suggested by L. H. Enslow, associated with the Chlorine Institute, through which the chlorine was supplied for this work. The chlorinator used throughout this investigation was lent by the Wallace and Tiernan Company. This apparatus was housed in a temporary building erected by us and a supply of water was piped to it from a nearby tap. The liquid chlorine was added to the raw sewage at a point where it entered the flowing-through compartment of the tank. It was added through a three-quarter inch rubber hose submerged 4 feet, at the rate, at first, of 50 pounds per day or 10 parts per million on the average daily sewage flow. This rate was increased to 70 pounds and then to 100 pounds or 14.5 and 20 parts per million respectively. Before any tests were made on the chlorinated sewage the chlorinator was allowed to run twenty-four hours.

At the 50 pound rate, free chlorine was detected in the first one-third of the tank. The analysis of the tank effluent showed that the hydrogen sulphide content had been reduced about 30 per cent, and the total bacteria count and *B. coli* had been somewhat reduced. The nitrification through the sprinkling filter was not affected by this partial chlorination.

At the 70 pounds rate, or about 14.5 parts per million calculated on the average sewage flow per day, free chlorine was detected in a little more than half the flowing-through compartment of the tank. The tank effluent showed a hydrogen sulphide reduction of about 75 per cent; the total bacteria count was reduced about 70 per cent, and the *B. coli* group about 80 per cent. This quantity of chlorine likewise had no effect on the nitrification through the filter.

It was found necessary to add 100 pounds of chlorine per day, or 20 parts per million calculated on the average flow, in order to obtain a positive free chlorine test in the tank effluent at all times. At this rate free chlorine was found in the final effluent of the plant from about midnight until about eight o'clock in the morning. When free chlorine is found, it is impossible for hydrogen sulphide to be present, for the reaction between chlorine and hydrogen sulphide gives hydrochloric acid and sulphur. Free chlorine in the tank reduces the total bacteria count about 80 per cent and the *B. coli* group is practically absent. This quantity

of chlorine did not seem to interfere with the normal functions of tank operation and it slightly benefited nitrification in the sprinkling filter, for without chlorine most of the nitrification took place in the bottom 1½ feet of the filter, which has an average depth of 4 feet 6 inches. But with the chlorine present the greater part of the nitrification took place about a foot higher up in the bed, or about 2 to 2½ feet from the bottom. In the absence of hydrogen sulphide an acrid odor was noticed in the sewage, but it is doubtful if this would ever create a nuisance beyond the plant itself as dilution with the air seems to render it innoxious.

It is estimated that the cost for the chlorination of Haddonfield sewage for five months a year would amount to about $1500, including cost of chlorine, depreciation, interest, etc. It is believed that chlorination from May to October would be sufficient as the cooler temperatures before and after this time do not favor the production of hydrogen sulphide.

TREATMENT WITH A SUBSTANCE THAT COMBINES WITH HE HYDROGEN SULPHIDE

Iron sulphate was used. This was purchased in the dry powdered form and a strong solution made by dissolving a known weight of it in a barrel of known volume. In this manner we calculated the rate of flow necessary in order to treat the sewage with 25 parts per million. This was applied to the raw sewage as it entered the plant. Ferrous sulphate combines with hydrogen sulphide to form insoluble ferrous sulphide and sulphuric acid. The iron was added to the sewage all night and the following day tests were made of the tank effluent and sprinkling filter. No hydrogen sulphide was detected and the tank effluent had an unmistakable sweet odor. The sprinkling filter effluent gave nitrite and nitrate figures about twice as high as previously obtained and the nitrification took place about in the center of the bed in place of in the bottom. It is believed that ferrous sulphate will greatly benefit the sludge. It is possible, however, that the building up of iron sulphide from the long continued use of the iron salt might become a potential source of hydrogen sulphide again, especially if pickling liquors or other acid-forming substances are occasionally discharged into the sewer.

CONCLUSIONS

Haddonfield, due to rapid realty developments, like most other municipalities in the vicinity of Camden, is facing a problem of controlling odors emanating from its sewage treatment plant.

All units of the plant are responsible for the production of odors. The greatest amounts are formed in the tank and liberated over the sprinkling filters.

Odors can be controlled by the use of chlorine or ferrous sulphate. At the Haddonfield sewage treatment plant it is necessary to maintain in the Imhoff tank effluent residual chlorine for the prevention of hydrogen sulphide odors.

The results obtained on the twenty-four hour tests and on the several tests run from noon until 1:30 A. M. show that the amount of hydrogen sulphide present in the tank effluent drops off rapidly after 1 A. M. and remains low, but variable, until about 3 P. M. The hydrogen sulphide then begins to increase again and reaches a maximum about 8 P. M., remaining nearly constant until about 1 A. M.

Making Tight Sewer Joints in Florida*

How Miami makes joints that, under four or five feet of ground water, show only six to eight thousand gallons of infiltration per mile per day

By R. L. Bow†

In preparing to eliminate infiltration of ground water into sewers, we must first determine what shall be allowed in the way of infiltration. In determining this allowable amount it was expected to tabulate the results of a questionnaire indicating ground water flow in sewers. This was given up owing to the lack of information available in many cities, the different methods of reporting infiltrations per mile, per acre or per capita per day. The results of a questionnaire sent out and reported in the October, 1927, issue of "Public Works" follows:

124 Cities reported "appreciable" infiltration
26 Cities reported "some" infiltration
22 Cities reported "very little" infiltration
115 Cities reported "no appreciable" infiltration

This article indicates that over half the cities reported infiltration ranging from unimportant wet weather increases to the entire capacity of the sewer. With these results and an investigation of tables compiled by Metcalf & Eddy indicating provision for 25% or 50% infiltration in intercepting sewers, and actual flows of 9,000 to better than one million gallons per mile per day, the importance of controlling infiltration is realized.

We find that frequently infiltration is specified and limited to 10,000 gallons per mile per day. This amount holds through all sizes of pipe and is sometimes questioned by contractors and some engineers, who maintain the larger pipe the greater the leakage. It is believed the 10,000 gallons per mile per day, regardless of size, is a fair allowance. In the larger sizes the pipe wall thickness increases as does the annular space to provide more room for better joints, and in still larger sizes it is possible to wipe the joints on the inside as an additional precaution against infiltration. This it is believed justifies the 10,000 gallons per mile per day. As a further demonstration of this, Long Beach, California, reports the following infiltration figures:

Station:	Size of Pipe	Miles of pipe below ground water	Infiltration per mile of submerged pipe per day
Naples	8-10"	2.73	26,200
No. 6	8-18"	3.38	7,450
No. 6	8-24"	1.71	5,490
Total:		7.82	39,140

Average per mile per day—5,000 gal.

We are indebted to Professor Charles C. Brown of the University of Florida for the following results, from the city of Lakeland.

* Paper before the Florida Enginering Society, slightly condensed.
† Engineer, Bureau of Inspection and Tests, Miami, Fla.

Observation of newly constructed sewers indicate the following infiltration:

Size of Pipe	Length of Sewers tested	Infiltration per mile of sewer per day
15″	0.6 miles	11,200 gallons
18″ to 27″	1.42 miles	40,600 gallons
24″ & 30″	1.6 miles	2,540 gallons
	3.62 miles	54,340 gallons
Average per mile per day		15,010 gallons

Observation of early morning flow on the completed sewerage system of the above city indicates the following flow, which has been taken as infiltration:

Size of Sewer	Length of Sewer	Infiltration per mile of Sewer per day
8″	1.42 miles	18,100 gallons
8″	.06 miles	9,100 gallons
8″	.096 miles	48,000 gallons
10″	4.15 miles	10,750 gallons
12″	7. miles	10,000 gallons
12″	7. miles	11,000 gallons
15″	3. miles	27,000 gallons
15″ between two manholes		85,000 gallons
8″ to 30″	30. miles	19,000 gallons

The last line of the table represents total infiltration of the system as a whole. Ten of the thirty miles represented is an old sewer and some waste and leakage would be incurred on them. The infiltration of this system per day amounts to 570,000 gallons. Sewers were built with "Presstite," G. K. and the old cement mortar joints.

From the city of Miami we have actual test results on new construction, each section between manholes tested for leakage under four foot head.

Contract	Length of sewer tested	Infiltration per mile of sewer per day
94	.9 mile	4403
95	6.7 mile	1200
97	8.2 mile	7025
110	.5 mile	3600

The quantity shown for contract No. 95 is actual flow at the pumping station on completion. Other contracts are construction test results, under four foot head, and final flow at pumping station would be much less. The above results represent some 250 tests which indicated infiltration from zero to 15,000 gallons per day per mile. Sewers were built with cement grout joints.

In theory and practice it is believed sewers can be built within this allowance. Present conditions and necessity of disposal plants demand that we stay within or below this figure.

Having specified a limit on infiltration, steps must be taken to insure that this is not exceeded. This will require rigid testing of the pipe furnished with careful inspection and testing of lines built. The usual testing laboratory can keep pipe within A. S. T. M. specifications and the following method of testing completed lines is recommended.

On both ends of the line erect riser pipes of sufficient height to create a four foot head of water at the low end of sewer, and measure the drop of water in riser pipe in a given time, which will indicate the leakage of the line. With many lines to test a table or a chart, as used in Miami, is recommended to eliminate much duplication of figures. In submerged lines the proportional flow of the sewer can be measured and leakage easily determined in the field.

This test is a wonderful incentive to the contractor to furnish good material and first-class workmanship.

In construction, use of the test mentioned will soon point out the defects in material and workmanship. Early experiment in Miami indicated an equal amount of defects in material and workmanship. It might be well to explain that this method of testing sewers was devised during the development of the sewer pipe joint now used in Miami.

Much trouble was experienced in Miami sewers through defective mortar joints and particularly so in the deeper cuts, where much water was found, and in sections of ditches impossible to unwater. Development of a satisfactory joint soon indicated the pipe manufacturers would have to better their product. This was accomplished by rigid testing and inspection and rejecting material that failed to comply with specifications. With good material and a satisfactory joint this test was written into and became a part of the specifications.

Considerable trouble was experienced in enforcing the test at first. First tests by new crews generally indicated a leakage of about 250,000 gallons per mile per day; however, by the time two or three sections of lines are relaid, tests are within the limit, the crews interested in laying tight lines and many lines pass without any corrections. As information, this test is regularly enforced on all lines at this time and has not increased the price bid on sewers in Miami, some fifty miles of sewer having been constructed the past year.

The greatest obstacle to overcome in eliminating infiltration was experienced in the joints. The age old mortar joint was found impossible to hold in place in the deep wet trenches on account of water. Patented joints were tried, and while these were made satisfactory on the bank, could not be made in the ditch. Under test the mortar joint, no matter how carefully made, showed almost unimaginable leakage. Patented joints made in the ditch either leaked or distintegrated under service in a few months. Joint trouble was eliminated by the use of a canvas form hemmed at both sides for wire and securely tied around the joint, which has been filled with a strand of oakum or jute. This form is then filled with a 1:2 cement and sand grout, the consistency of thick cream, to the top of the form which is carried to the top of the pipe barrel. The top of the joint is finished off with a handful of stiff mortar just before the initial set of the grout. In wet or soft bottom ditches, the use of a 1¼-inch hose with a funnel is recommended in pouring the joints. The hose being slipped in the form and pushed by the bottom and up the opposite side. This prevents the cement and sand from separating in falling through the water, and as the joint fills, the hose is pulled back out of the form and its place taken by grout before any soft material in the bottom of the ditch can force the form against the pipe and prevent this portion of the form from filling. This joint has proved more successful than any other known; it is being used successfully in construction where the water is up to the top of the

pipe; develops a strength greater than the pipe; is not prohibitive in cost, and material is available almost anywhere sewers are built.

This test and joint has been used on either vitrified clay or concrete pipe with equal success. Trouble has been experienced with both kinds of pipe but at this time remarkably little trouble is experienced with pipe. In this respect the pipe manufacturers deserve much credit for while 1% of the pipe is tested for compression and hydrostatic qualities in the laboratory, a full 100% must undergo a hydrostatic test in the ditch to pass this test. Completion reports on completed sewers in Miami with outlet in pumping stations show a leakage of six to eight thousand gallons per mile per day. The inverts of these lines are as much as four and five feet below the normal elevation of ground water.

Progress on Cuba's Central Highway

Work on the central highway of Cuba, which was provided for by the Public Works law of July 15, 1925, and has been referred to in PUBLIC WORKS, is reported to be ahead of its schedule. After the contract had been awarded to Warren Bros. of Boston and the Cia. Cubana de Contratistas early in 1927, for this 705-mile road at an estimated cost of $76,000,000, several months passed before work was well under way; but by November, 1927, activity had become more intensive and since that time has gone forward steadily, simultaneously in the six provinces. During February, March and April of this year, more than $2,000,000 worth of work was done monthly. Rain checked the work during June, but since then it has been going on again at greater speed. At the end of August the length of highway completed with Warrenite surface aggregated 194 kilometers, not in one continuous line but distributed in five of the six provinces. Most of the completed work, however, lies in Havana and Pinar del Rio provinces. About 60% of the total necessary bridges have been built. Unless the present schedule is modified, the central highway will be completed on or before June 30, 1930.

The $76,000,000 which this highway is estimated to cost is only part of a 20-year special tax program calculated to provide $320,000,000. The balance is

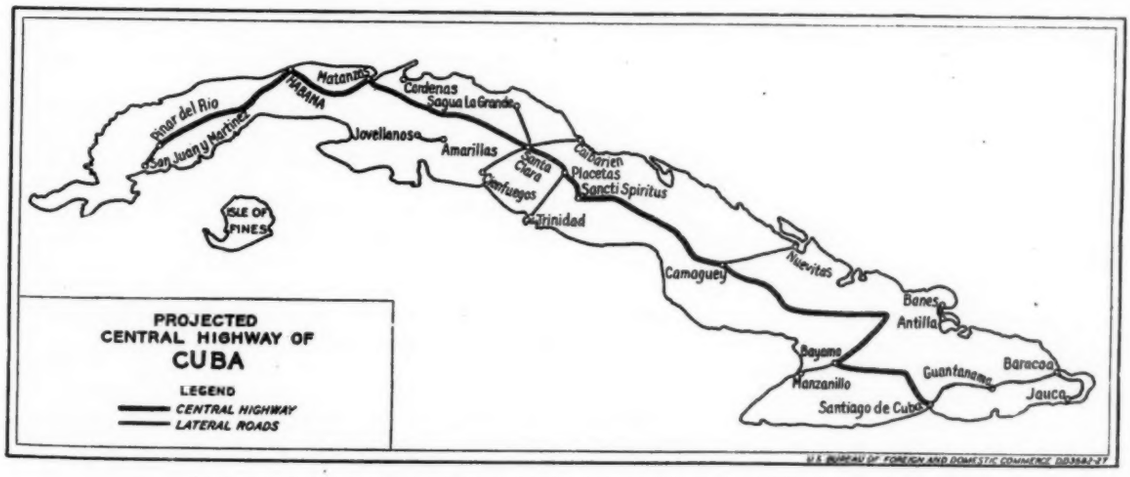
WORK ON CUBA'S CENTRAL HIGHWAY
United States equipment—"Caterpillar" tractor and P. H. shovel—being used

to be invested in other public works consisting of school houses, aqueducts, sewerage systems, public buildings and, notably, construction of lateral roads connecting this highway with ports on the northern and southern coasts of Cuba. Work has already begun on one of these roads to Bayamo, the contract being held by Warren Bros.; while work on a road from Santa Clara to Cienfuegos has been going on for a number of months and 30% has been finished. Contracts have been let for two or three more roads connecting some of the principal cities in the central and western end of the island; while plans have been prepared more or less completely for many other roads throughout the entire length and breadth of the Island.

Highway Between Canada and Portland, Maine

A new international highway linking Three Rivers, Quebec, with Portland, Maine, will be officially opened this autumn. It will be named the Arnold Trail as it will follow the route used by General Arnold when he invaded Canada with his troops after the outbreak of the Revolutionary War. It will shorten by many miles the distance between Quebec and New England centers and will be an ideal route for tourists for it will pass through one of the most beautiful parts of Quebec.

Leaving Portland, Maine, the road will pass through Lewiston, Lake Rangley, Webb's Pond, Lake Richardson, and Lake Spider, crossing the



THE "CENTRAL HIGHWAY" OF CUBA AND CONNECTED LATERALS

border at Eustis and continuing through St. Augustia de Wobun, to Victoriaville and Three Rivers, Quebec. The U. S. Department of Commerce announced on August 24 that there still remained 2½ miles to be completed on the Canadian side and 22½ on the American side, and that work was being pushed so that it could be opened up this year.

Highways of Sao Paulo, Brazil

On April 15, 1927, there was created in the state of Sao Paulo, Brazil, a State Bureau of Public Roads, and during that year studies were made for 702 kilometers of new state highways, and 329 kilometers of highways were added to the state highway system. At the end of 1927 the state highway system consisted of 2,386 kilometers, made up of 1,575 kilometers of improved dirt road and 811 kilometers of hard-surface roads. The total movement of vehicles over the state highways during that year was made up of 722,498 passenger vehicles and 534,713 trade vehicles, 633,679 of the passenger vehicles being automobiles and 88,819 animal drawn This was an increase over the preceding year of 290,501, composed almost entirely of increase in automotive transport, as animal transport showed relatively small increase.

Preliminary Report on Highway Subsoil Investigation In Ohio

By C. N. Conner

This report appears in an unpublished bulletin of the Engineering Experiment Station, Ohio State University, Columbus, Ohio. The investigation and report were made by F. H. Eno, Research Professor of Highway Engineering, Ohio State University.

Highway engineers and constructors of roads always welcome information on their problems. This is particularly true of subgrade and drainage problems, because an atmosphere of uncertainty has long surrounded them. Any additional definite information which is presented in clear, concise and understandable language is greatly needed at this time.

Whether or not complete agreement can be made with all of the findings of this report and regardless of the results obtained locally by others, it is a distinct addition to our present knowledge of a most important and difficult subject.

In addition to the actual studies made for this report, its author, Dr. Eno, has been a close student of subgrade conditions for more than ten years.

The following introductory remarks, general conclusions and practical applications are among the important inclusions of his report:

This is a brief resume of the results obtained in the highway subsoil investigation in Ohio, carried on as Project No. 17 of the Engineering Experiment Station in cooperation with the United States Bureau of Public Roads and the Ohio State Highway Department. Information now available (March, 1928) has been gleaned from observations in the field, from the laboratory experiments, and from work of other investigators. This study has led to the following general conclusions and recommendations:

GENERAL CONCLUSIONS

Occurrence of Road Failures. 1. Road failures seldom occur in sandy or gravelly soils.

2. In relatively thin pavements, more failures occur in the clay than in the loamy soils.

3. In rigid pavements of substantial thickness, failures may occur in any soils of appreciable plasticity. Evidence does not indicate that such factors as high clay content, or high moisture content of the soil in the field necessarily mean failure. They may be contributory to failure, however, if they occur with other factors at present unknown.

4. Appreciable seasonal vertical pavement displacement appears to increase the danger of failure.

5. Failures occur in cuts where springs, seepage and water table moisture are encountered. The highway engineer, in reducing grades and curvature of the highway by deep cuts, has not always taken the precautions for proper drainage.

6. Failures occur in cuts where the grade intersects successive soil layers of varying permeability.

7. Failures occur at bridge abutments, culvert abutments and at cross drainage points where the back fill has not been properly compacted.

Vertical Displacement of Pavements. 8. Vertical pavement displacement may be caused by frost action or by the swelling of the soil because of increased moisture content.

9. The amount of displacement observed in Ohio from 1924 to 1927 has varied from 0.025 to 0.0265 feet annually. The pavement settles back each summer to its original position. Northern states are known to have much greater uplifts.

10. Of the eight stations which showed annual heaving in excess of 0.100 feet, failure had occurred at four. The only other failure which had occurred in the 21 stations was the one showing a maximum displacement of 0.051 feet.

11. Pavement displacement was observed only on clay soils, but no relation was found to exist between the pavement displacement and the amount of clay in the soil except that the clay content was less where the heaving was greatest. For the eight stations showing displacements greater than 0.100 (average 0.147) the average clay content was 48 per cent, and for the thirteen stations showing displacement less than 0.100 (average 0.066) the average clay content was 59 per cent.

12. No relation was found to exist between the pavement displacement and moisture content of the soil either at the surface or 12 inches below. The moisture content at the surface was slightly less and that at 12 inches below the surface was slightly more where displacement was large than where it was small.

13. No relation was found to exist between the pavement displacement and the generally related soil tests—capillary moisture, moisture capacity, moisture equivalent, volumetric shrinkage at capillary moisture, lower liquid limit, lower plastic limit, and plasticity index. Where the larger displacement occurred, certain of these tests (capillary moisture, moisture capacity, and volumetric shrinkage at capillary moisture) gave slightly larger average values, and certain others (moisture equivalent and lower plastic limit) gave slightly smaller average values than where the smaller displacement occurred.

Frost Action. 14. The behavior of sand-clay subgrades during freezing is quite different. Weights placed upon wet clay soils were lifted by the gradual formation of pure ice between the weight and the clay. Weights similarly placed upon wet sand were not lifted, although the water in the voids of the sand was frozen.

15. Noticeable heave from frost is confined to clay and other soils with extremely small voids. Ice forms first in the larger openings, along planes of cleavage and other weak planes. The thickest layers of ice are found under objects which radiate heat rapidly.

16. When a clay soil is saturated and the freezing process is not too rapid, the water freezes at the surface of the soil in the form of ice needles normal to the soil surface. As freezing continues the needles continue to push up as the capillary water is brought to the base of the needles and freezes. These needles form layers of free ice on the soil surface. It is believed that a modified form of this occurs beneath pavements.

17. The softening of road shoulders and subgrades in the spring is due to the frozen soil beneath the thawing surface acting as an impervious basin which retains the excess water from the thaw in contact with the surface soil.

Moisture Content of Soils. 18. The moisture content of clay subsoils in Ohio, from 12 to 30 inches in depth, as observed at 45 stations, remains rather constant at about 24 to 40 per cent of the volume of the soil (15 to 25 per cent of the dry weight of the soil). Beneath pavements it maintains a constant moisture of about 32 to 40 per cent of the volume of the soil (20 to 25 per cent of the dry weight of the soil).

19. No relation was found to exist between the observed moisture content and such factors as the clay content of the soil or the results of the related tests.

20. Fluctuations occur in the water content of subgrade soils, which it is impossible from present data to trace directly to rainfall, evaporation, or other surface weather conditions.

21. For the dry portion of the summer or fall, the water content of the subsoil may be from 60 to 65 per cent of the water content during the winter and spring.

22. Due to unknown factors, certain soils show nearly double the moisture content at all times as do other soils.

23. The moisture content of the top six inches of soil beneath a concrete slab is less variable than that of the top six inches of soil covered with a sod.

24. For depths greater than 6 inches, the moisture content under a concrete slab can be greater or less than in adjoining soil covered with sod. Generally it is 2 to 5 per cent greater, but in wet seasons was found to be 2 per cent less than in the sod-covered soil.

25. Covering the soil with a concrete slab reduces evaporation and thus increases the moisture content of the subgrade from 2 to 5 per cent.

26. The moisture content of subgrade soils may often exceed the lower liquid limit. Of 700 observations (on the same soil) extending over three years, the lower liquid limit was exceeded 109 times beneath the slab and 116 times in the sod-covered soil.

Brick road with 4-inch concrete base in cut over softened subgrade

Excessive moisture beneath pavement causes longitudinal cracking in brick road

Badly broken concrete due to water which is carried by porous surface soil down to an impervious stratum which is cut by the road excavation at this point

DESTRUCTION OF PAVEMENT SURFACES DUE TO WET SUBGRADE

Surface materials themselves are in no way responsible for these failures

Capillary Moisture. 27. Normal capillary moisture of some heavy soils cannot be increased by flooding the side ditches for six weeks or more.

28. The capillary capacity of a soil depends upon the clay-silt content, the colloidal activity, temperature and the distance from the source of water supply. It is reduced by reducing the clay-silt content (i.e., by the addition of sand), by increase in tem-

perature, and by increasing the distance from the source of water supply.

29. Observations for three years on the Bates road showed no measurable difference between the moisture contents of the subgrade of two adjacent sections of road, one tiled along both edges, the other not tiled.

30. On the Chatham road (Illinois), in soil different from that on the Bates road, tile were installed 42 inches beneath the edges of the pavement for 1,000 feet. Extended observations showed the moisture content beneath the road on the tiled section to be from 2 to 10 per cent greater than under the adjoining untiled sections.

31. From statements 29 and 30 it should not be concluded that drain tile and ditches have been ineffective for intercepting and removing free gravitational water, nor for lowering the water table and thus reducing the capillary moisture.

Sub-bases and Sub-base Treatments. 32. Porous sub-bases with proper drainage under flexible pavements stabilize and increase the subgrade support.

33. Insulating layers of fine porous materials such as granulated slag, cinder, stone screenings, sand, etc., placed between the subgrade soil and the sub-base prevent the finely divided subgrade soil from working up into the interstices of the sub-base fragments.

34. Evidence as to the benefit of porous sub-bases used under modern rigid pavements is contradictory.

35. Rigid pavement sections on Route 32, Union County, Ohio, laid on a saturated heavy clay soil with and without porous sub-bases have developed, after two years of service, mainly transverse cracks. A small amount of longitudinal cracking (ratio 0.02) occurred in sections laid on natural soil. Transverse crack ratios were as follows: For the pavement on natural soil, 0.35; on porous stone bases, 0.50; and on porous gravel bases, 0.40 feet of crack per lineal foot of pavement. The sub-bases had side drainage.

36. Rigid pavement sections, on Route 26, Washington county, laid on heavy clay subgrade, both with and without porous sub-bases, show, with one exception (6-inch gravel), a higher longitudinal crack ratio and a higher total crack ratio in sections on natural soil than in sections laid on sand, gravel and slag sub-bases. With one exception (6-inch sand), all sections laid on porous sub-bases show less transverse cracking than do those laid on natural soil. The sections laid on the slag sub-bases show less corner cracking than those laid on natural soil. With one exception (2-inch gravel), the sections laid on sand and gravel sub-bases show more corner cracking than those laid on natural soil. With two exceptions (4 and 6-inch slag), the increase in total cracking during the past year is more for sections laid on porous sub-bases than for those laid on natural soil.

37. The evidence on the benefits of cement-soil and lime-soil admixtures as sub-bases is contradictory.

38. Sections in Route 32, Union county, laid on lime-treated soil showed about the same cracking, and sections laid on cement-treated soil showed less transverse cracking, than those laid on natural soil.

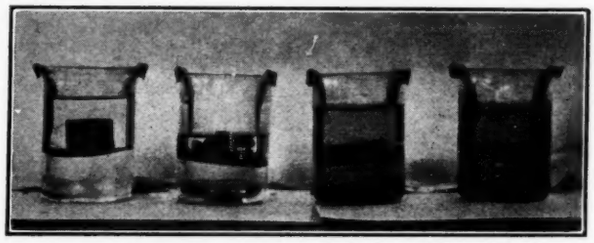
39. Sections in Route 26, Washington county, laid on cement-treated soil showed less total cracking, but more transverse and corner cracking and a greater increase in total cracking during the last year, than did the sections laid on natural soil.

40. Cement-soil and lime-soil admixtures for road sub-bases in Ohio are impracticable because the variable weather conditions and the plastic character of the soil prevent uniform mixing.

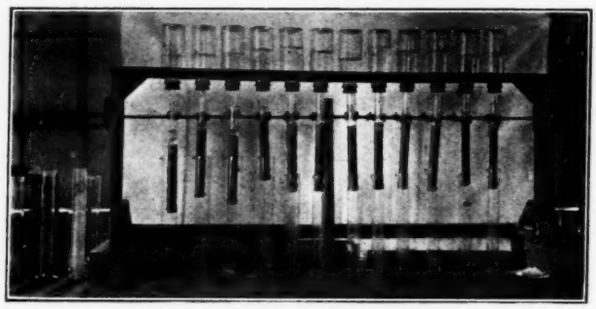
41. Tarred paper between the sub-base and the concrete pavement laid upon very absorptive soils in Iowa prevented the checking of fresh laid concrete.

Soil Characteristics. 42. The rapidity with which soils disintegrate when subjected to free water is indicated by a simple slaking test.

43. A percolation test may be used to indicate: first, whether a soil is or is not drainable; second, whether special drainage facilities should be placed beneath pavements laid on impermeable soils to drain away free water which will collect there.



MAKING THE SLAKING TEST
Showing how different soils slake, some to liquid mud, some to granular masses, others to chunks, and some stand up in water indefinitely



PERCOLATION TEST
Showing tubes of soil with constant water heads maintained by atmospheric pressure in the inverted bottles above the tubes

44. It is the opinion of many soil scientists that practically all of the clay fraction (grains less than .005 mm.) is colloidal in nature.

45. They believe also that such factors as swelling, shrinkage, plasticity, quick slaking, non-permeability, waterholding capacity, etc., are due to the colloidal content of the soil.

46. In general, the nature of a soil cannot be expressed by a single constant nor by any number of related constants. Two soils may be the same with respect to one characteristic and yet be different with respect to another or all other properties. Hence any routine program for soil identification must include such tests as will reflect independent and different soil characteristics.

For instance, from soil analyses of 20 stations where the road conditions were bad, the clay contents of the soils varied from 39 per cent (about 20 per cent by Bureau of Soils analysis) to 86 per cent, the lower liquid limits varied from 18 to 50 per cent, the plasticity index varied from 4 to

29 per cent, the volumetric change varied from 11 to 28 per cent, and the moisture equivalent varied from 12 to 31 per cent. Within these limits the failures were evenly distributed. Also, it was found that a great number of roads laid on soils having constants of similar limits have not failed. These tests are all generally related and can be said to reflect similar characteristics. Thus, to furnish more definite information on questionable soils (having constants within the limits noted) these tests must be supplemented by others which furnish information on different characteristics.

47. Concrete distributes the pressure upon the subgrade from superimposed loads over a greater area than when the load is distributed through a broken stone pavement. At Arlington the maximum pressure upon the soil was 0.8 pound per square inch through 8 inches of concrete and 6.4 pounds per square inch through 8 inches of broken stone for a 4000-pound load.

48. Upon homogeneous soils, for a given unit load, the depth of penetration varies directly in proportion to the square root of the area loaded. To illustrate, assume a given load upon an area of one square foot produces a penetration of 0.3 of an inch, then a load nine times as great upon an area of 9 square feet will produce a penetration of $\sqrt{9} \times .3$ equals .9 inch.

PRACTICAL APPLICATIONS

1. Increasing evidence emphasizes the fact that top soil is more stable and more easily drained than

IMPERVIOUSNESS OF SOIL SHOWN BY WATER STANDING IN RUTS SEVERAL DAYS AFTER A RAIN

subsoil. Therefore, keep roadbeds up, avoid cuts, and provide frequent and ample drainage outlets away from the roadbed and away from the right of way.

2. Tile drains are of little value in tight, dense soils. Notice whether water sinks quickly into the soil or whether it stands in wheel tracks and ruts until evaporated. This simple observation enables the engineer to decide whether drains will or will not act at that particular place. If the soil *is* impervious, then special provision should be made to remove water from the road bed beneath the pavement, for water will collect from various sources.

3. From a study of 20 stations in Ohio where road conditions were bad, it may be concluded that trouble may occur whenever the clay content exceeds 40 per cent by Ohio method of determination (20 per cent by Bureau of Soils methods). This substantiates the findings of the Bureau of Public Roads in the Pacific Northwest.

4. This does not mean that substantially built pavements laid on these soils (which form the great majority of subgrade soils in Ohio) will fail either wholly or in part. It means that, with certain attendant conditions, some of which are at present unknown, failures may occur in these soils.

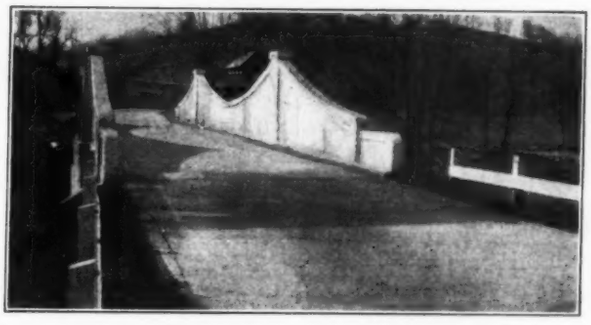
5. Generally, soils having more than 40 per cent clay (Ohio determination) will have test results greater than the following:

	Per cent
Volumetric change at capillary moisture (shrinkage)	18
Moisture equivalent	20
Capillary moisture	28
Lower liquid limit	23
Plasticity index	13

These limits, in general, agree with the lineal shrinkage value of 5 per cent suggested by A. C. Rose and now used by the states of California and Colorado.

Patch shows break in concrete road caused by spring beneath road

Rut at edge of new concrete pavement



Dark area in front of bridge is patch on concrete pavement, where settlement occurred because of poorly compacted back-fill

See page from a blocked ditch caused breaking up of this brick pavement

DEFECTS DUE TO SPECIAL SUBGRADE CONDITIONS

6. These clay and clay-loam subgrades should be very carefully inspected, especially in cuts, for water-bearing strata, seepage, springs, soft spots, and adjacent layers of soil having widely different characteristics. Special drainage should be provided where needed.

7. Avoid so far as possible the peaty, mucky and abnormally heavy soils. When these cannot be avoided and when conditions noted in No. 5 are encountered, use some method to compensate for the lack of stability on the subgrade. The precaution to be taken will vary with the type of pavement used and the soil condition encountered. These precautions may concern the design of the pavement, the stabilizing of the subgrade, or both.

8. For flexible pavements, in case the soil changes from a stable to a more unstable class, the experience of Rhode Island may be followed by first making proper provision for removing all free water and then replacing a given depth of the poor soil by a uniform layer of gravel, slag, or other good porous material. The depth of this porous layer should be governed by the traffic to be supported and the degree of instability of the soil.

FINE BRICK ROAD WITHOUT DITCHES, NATURALLY DRAINED BECAUSE LAID ON A GRAVELLY OLD LAKE SHORE RIDGE

9. Whenever macadam roads are laid on muck or plastic soils, a blanket layer of fine porous material should first be spread on the subgrade throughout the length of the poor soil section.

10. For rigid pavements, under similar conditions to those noted in 5 and 6, there are three methods of meeting the situation by change in slab alone: First, by thickening the slab; second, by reinforcement; third, by changing the joint spacing, i.e., by lengthening the slab to cover short muck holes, or by reducing slab lengths over longer stretches of bad soil.

11. In building roads over swampy, boggy or "spouty" places, it is well to remember that rigid pavements distribute the load more widely and evenly than do flexible pavements. According to the Arlington tests, 8 inches of concrete was 8 times as effective as 8 inches of broken stone. Depth of paving material also decreases the unit load distributed to the soil.

12. Porous sub-bases have been used extensively to increase the stability of the subgrade. There is much contradictory evidence as to their value when used under rigid pavements. One weakness in the use of porous bases has been in the careless use of any kind of porous material and the failure to secure perfect drainage. Upon very plastic or peaty soils the first layer of the sub-base should be fine material to blanket the plastic base, the coarser porous material being placed on top. There is sufficient favorable evidence to warrant a trial of porous sub-bases when soil conditions demand some remedy.

13. For low cost roads, the porous sub-base is just as essential, even more so, than for the high-type road, but care must be taken to wet or compact the porous sub-base sufficiently so that the lower course of stone in the road will not be rolled too deeply into the porous base.

14. Where roads cross swales or shallow natural water courses, remember that not all of the water travels on the surface. In many cases there is regular underground water movement beneath and parallel to the surface course. This should be intercepted and not allowed to pass beneath the road.

15. Where excavated channels or depressions in the subgrade have been made below subgrade elevation, be insistent upon the compaction of the backfill. It is worth the extra cost of backfilling with sand, gravel or loam in order to obtain a uniformly solid sub-base. At bridge abutments and like places, reinforced concrete may be required over such fills.

16. Heavy soils, when dry, take up water readily and expand accordingly. When the water evaporates from them a corresponding shrinkage occurs. When they contain the normal capillary moisture or slightly less and are protected against evaporation by a superimposed pavement, they resist taking up additional moisture and are loath to give up that which they have. Thus, a clay subgrade when moist is subject to less contraction and expansion than when dry. Therefore, when building a road upon a heavy clay sub-base, if the soil is dry, spray the base until it will compress under the roller rather than crumble under it.

17. Lower temperatures increase the capillary moisture in subsoils. Porous sub-bases decrease the rapid fluctuations of temperature beneath pavements and reduce its intensity. Therefore, porous sub-bases will reduce the amount of capillary moisture beneath a pavement, provide a certain degree of ventilation, and thus should decrease a part of the troubles arising from poor soil conditions. They also offer better opportunity for free drainage from beneath the pavement.

18. Under the climatic conditions in Ohio, it is impracticable to attempt to improve subgrade soils by mixing dry materials with them, because the soils which need treatment are extremely tough and plastic and are kept so by frequent rains.

19. The quick slaking of a soil probably endangers the edge of a road more quickly than any other soil property exhibited, for the shoulders of a new road are usually of the natural subgrade soil and are not ordinarily protected immediately upon completion of the road. Deep ruts may thus be formed at the immediate edge of the road and later by the slaking process the edge may be undermined, leaving it with no support.

The remedy is a gravel, stone, cinder or slag top put upon the shoulders next to the road to prevent rutting. This material should be waterproofed with tar or asphalt to prevent the admission of water to the sub-base.

20. Some soils are very absorptive of water and may seriously injure concrete by drawing water from the fresh laid mixture. Thorough drenching of sub-bases in such soils or covering them with tarred paper may prevent the trouble.

Public Purchase of Materials for Contract Work

The Municipal Reference Bureau of Cincinnati, under date of July 26th, 1928, addressed inquiries to the state highway commission or corresponding authority in each of the 48 states, to 35 county engineers or corresponding officer in that number of the larger counties in the United States, and to 90 city engineers, including those of all cities of as many as 100,000 population; these inquiries asking for information concerning the practice of each of these in connection with the purchase by them of materials for public works, to be furnished to contractors. Replies were received from 41 states, 24 counties and 62 cities. From these replies the following tabulations and analyses have been prepared.

EXTENT OF PRACTICE

State.—Twenty-one states—if Alabama be included—report that they now furnish some material to contractors. Of the twenty-one, two resort to it in special and exceptional cases only, one expects to abandon, and one reports it as diminishing; one furnishes material of which about one-half is a state product, and another requires contractors to purchase a state product.

Another state, from which no direct report was received, is said by one of the county reports to furnish portland cement.

Another state, not included among the twenty-one takes bids in behalf of contractors who are then permitted to purchase directly at the prices obtained and guaranteed by the state.

Two states, among the twenty-one, have abandoned the practice as to certain materials while continuing it as to others.

Four states report complete abandonment of their former practice. Two report that they also considered the matter and declined to adopt the practice.

Counties.—Five counties report that they now furnish some material to contractors.

Another reports that it was used upon special occasions.

Another reports that it purchases certain materials for repairs only. It is not certain from this answer whether these repairs are made by contract or by the direct employment of labor.

Three report the abandonment of the practice entirely, and one of the five reports a diminished use of it.

One state highway commission wrote that two unnamed counties, from which the Bureau did not inquire, follow the practice.

Cities.—Thirteen cities report that they now furnish some material to contractors. Of these thirteen one does it in special cases only, one very rarely.

One tried the method once and found it successful.

Two cities take bids and guarantee prices to contractors, as described of one state.

Four cities which formerly used the practice report its complete abandonment.

Two of the thirteen cities use the practice as to fewer materials than formerly.

EXTENT OF USE, BY MATERIALS

The material which figures most extensively in the experiences reported is portland cement. The materials upon which the results of experience are most nearly uniform are culvert pipe, and sewer pipe and castings.

But it should be said that as to the items last named the Bureau inclines to believe that the practice under discussion is more widely followed than the replies indicate. The reply form did not specifically mention them, and in some cases the authority furnishing the reply may not be in direct contact with sewer work. (See Tables, I, II and II.)

ADMINISTRATIVE METHODS

Basis of Contractor's Bids.—Most of the authorities which furnish materials require contractors to bid upon the basis of using materials furnished. A few allow the contractors to submit bids upon the basis of using materials furnished by themselves, or upon both bases.

Quantity Basis of Purchases.—Relatively few responses were received to an inquiry whether purchases were made on the basis of requirements for a year, a season, or each project. However, six states and five cities reported using the yearly basis; one county uses the season basis; and five states and a county the project or job.

Delivery Arangements.—Such reports as reply to inquiries as to delivery arrangements are all alike in indicating that vendors deliver at or near the site of the job. If any jurisdiction purchases and stores, the circumstance is not disclosed by these replies.

Workmanship, etc.—Inquiries as to waste of furnished materials, and as to the ease or difficulty of securing the use of the full amount of material required and of securing satisfactory workmanship, produced a number of replies, a few of which report no difference, and most indicated some greater ease in these particulars as against construction wherein the contractor furnishes all material.

DISADVANTAGES

Not all the authorities which have abandoned the practice under discussion have done so by reason of very positive disadvantages. Some of the particular difficulties which arose in particular cases do not go to the general merits. In a few cases no disadvantages appear to have figured in the discontinuance. In others it was rather the apparent absence of either advantage or disadvantage that led to the discontinuance. And it should be noted that in a number of jurisdictions the practice is retained for certain items after its abandonment as to others.

Extent of Practice of Purchasing Materials to be Furnished Contractors for Use in Public Works.

TABLE I—By State Highway Authorities

	General	Portland Cement	Aggregates	Asphalt	Culvert Pipe	Gravel Surfacing	Reinforcing Steel	Miscellaneous	Paint	Bridge Material
Alabama*	....	(1)	....	(1)	(1)	....	....	....	....	....
Arkansas	....	....	....	....	....	(1)	....	....	....	....
California	....	(3)	(3)	....	(1)	....	....	(1)	....	....
Colorado	(3)	....	....	....	....	....	....	....	....	....
Connecticut	....	(1)	....	(1)	(1)	....	....	....	....	....
Delaware	....	(3)	(3)	....	....	....	....	....	....	....
Illinois	....	(1)	....	....	....	....	....	....	....	....
Indiana	....	(1)	....	....	....	....	....	....	(1)	(1)
Iowa	(8)	....	....	....	....	....	....	....	....	....
Michigan	....	(1,2)	....	....	....	....	....	....	....	....
Minnesota	....	(13)	....	....	....	....	....	....	....	....
Mississippi	....	....	....	....	....	(1)	....	....	....	....
Missouri	....	(1)	(1)	....	....	....	....	....	(1)	....
Montana	....	(3)	....	....	....	....	....	....	....	....
Nevada	....	....	....	....	(1)	....	....	....	....	....
New Hampshire	....	....	....	(4)	....	....	....	....	....	....
North Carolina	....	(1)	....	....	(1)	....	....	....	....	....
Oregon	....	(3)	....	(3)	....	....	....	....	....	....
Pennsylvania	(5)	....	....	....	....	....	....	....	....	....
Rhode Island	....	....	....	(1)	(1)	....	....	....	....	....
South Carolina	(5)	....	....	....	....	....	....	....	....	....
South Dakota	....	(6)	....	....	(1)	....	....	(1)	....	....
Tennessee	....	(1)	(1)	(1)	....	....	....	....	....	....
Utah	....	(1)	....	....	(1)	....	(1)	....	(1)	....
Virginia	....	(1)	....	....	....	....	....	....	....	....
Washington	....	(7)	....	....	....	....	....	....	....	...
West Virginia	....	(8)	....	....	....	....	....	....	....	....
Wisconsin	....	(3)	....	....	....	....	....	....	....	....
Wyoming	....	....	....	....	(1)	....	....	....	....	(1)

* Alabama State Highway Department gets dealer's discount and cash discounts, as contractors are not always able to do. "We operate 12 camps that use convict labor and purchase all cement, aggregates and other construction materials as well as equipment for them."

TABLE II—By County Engineers

Counties										
California Los Angeles Co.†	....	....	....	....	....	....	....	....	....	(1)
Illinois Cook Co.	....	(1)	....	....	....	....	....	....	Joint Material	....
Kansas Sedgwick Co.	(3)	....	....	....	....	....	....	....		....
Michigan Wayne Co.	..	(1)	(1)	....	....	....	....	....	(1)	....
Minnesota St. Louis Co.	..	....	....	....	(1)	(1)	....	....	....	....
Oregon Multnomah Co.	....	(14)	....	....	....	....	....	....	....	....
Pennsylvania Allegheny Co.	. ..	(3)	....	....	....	....	....	....	....	....
Texas Harris Co.	...	....	....	(10)	....	(1)	....	....	....	....
Washington King Co.	..	(1)	....	....	....	....	....	....	....	....
Wisconsin Milwaukee Co.	...	(3)	....	....	....	....	....	....	....	....

† "It is only for a certain class of bridge construction that this Department furnishes such material as is not obtainable for immediate delivery from the local market, but has to be shipped in from distant points. This would delay the contractor starting the work. This material consists of pieces, both treated and untreated with creosote, creosoted lumber, heavy dimension lumber not carried in regular stock at lumber yards, and steel 'I' beams of standard dimensions."

Key: (1) Purchases in market and furnishes to contractor.
(2) Furnishes state product.
(3) Abandoned practice.
(4) Intend to abandon.
(5) Practice considered and not adopted.
(6) Requires use of state product.
(7) Contractor purchases at prices secured and guaranteed by authority.
(8) Special cases only.
(9) Practice is diminishing.
(10) Repairs only.
(11) Laws do not permit.
(12) Rarely.
(13) Reported by Ramsey County.
(14) One occasion only.

The most vital disadvantage appears to be in the difficulty of securing timely deliveries. Several reports mention that in such case the authority has to bear the responsibility for delay, and even to indemnify the contractor for his losses caused thereby. This difficulty does not appear to figure with those who continue successfully to use the method.

Akin to that difficulty is another, the annoyance of the responsibility for materials furnished, and the additional clerical work involved.

TABLE III—By Cities

City	General	Portland Cement	Brick	Wood Block	Paint	Sewer Pipe, Etc.	Castings	Water Works Material	Bridge Material
Camden	(8)	....	....	....	....	....	....	....	....
Charleston	....	....	(14)	....	....	....	....	....	....
Chicago	....	....	....	....	....	....	....	(1)	....
Cleveland	(5)	....	....	....	....	....	....	....	....
Dayton	....	....	....	....	....	....	....	....	....
Detroit	....	(3)	(3)	(3)	....	(1)	....	....	....
Flint	....	(1)	....	....	....	....	....	....	....
Grand Rapids	(12)	....	....	....	....	....	....	....	....
Houston	....	....	....	....	....	....	....	(1)	....
Jacksonville	....	....	....	....	....	(1)	(1)	....	....
Los Angeles	....	(3)	....	....	....	....	....	....	....
Memphis	....	....	....	....	....	(1)	....	....	....
New Orleans	(11)	....	....	....	....	....	....	....	....
Norfolk	....	....	....	....	(1)	....	....	(1)	....
Pittsburgh	....	....	....	....	....	....	(1)	(1)	....
Providence	....	(1)	(1)	....	....	(1)	....	....	....
Reading	....	(14)	....	....	....	....	....	....	....
Richmond	....	(1)	(1)	....	....	....	....	....	....
Rochester	....	(14)	....	....	....	....	....	....	....
San Antonio	....	(3)	....	....	....	....	....	....	....
Seattle	(7)	....	....	....	....	....	....	....	....
Spokane	....	(7)	....	....	....	....	....	....	....
Wichita	....	(3)	(3)	....	....	....	....	....	....

ADVANTAGES

The outstanding advantage cited by authorities which do furnish material is the saving in money cost. This is achieved by virtue of purchasing in greater quantities and at more favorable times than could be done by one contractor; by trade and cash discounts; by transportation cost differentials; by tying up less of the contractor's capital; by avoiding the margin which the contractor would add to his costs for the same material; by using state products; etc. The amounts of such savings reported are not susceptible of summary statement or comparison.

In the case of sewer pipe, castings, bridge material, etc., it appears that the additional advantage of timely and proper delivery is generally obtained, to a greater degree than when the contractor furnishes the material.

In addition, certain authorities are of the opinion that they more surely obtain the use of good materials in the full amount, better workmanship and better inspection, when certain materials are furnished.

RELATED METHODS REPORTED

The practice reported by the state of Washington and the cities of Seattle and Spokane, therein, appears to be designed to secure any price advantage to be obtained by the exercise of the larger purchasing power of consolidated contract requirements, without incurring any administrative difficulties inhering in the actual handling of material. The contractor is guaranteed that he may procure material under the bid accepted by the public authority, and bids upon that assurance. The supplier has the assurance of a volume of business which enables him to bid well.

DETAILS OF PRACTICE

Most of the informants accompanied their data with more or less complete explanations, some of the more interesting of which are quoted or abtracted below.

California.—"During the early part of construction the Highway Department furnished all of the cement, part of the aggregates, all of the corrugated culvert pipe, and a few other minor items. More recently the state has abandoned the supplying of cement and concrete aggregate to contractors, but is still supplies the corrugated culvert pipe, expansion joint material and some minor items. These are purchased for each job separately by the Purchasing Department based upon competitive quotation. There is no financial advantage in this manner of handling these materials, but it does give a better control of the kind used."

Colorado.—The state has abandoned the practice, which "gave the contractor just another opportunity to wrangle and present claims for delay."

Delaware furnished cement and stone for about a year during the war as an emergency measure, but since then has abandoned the practice.

Illinois—"Each year the department enters into contract with the cement companies for furnishing enough to carry on the year's construction program. We feel that this system has several advantages and have found the practice satisfactory after several years' experience."

Indiana finds as the only disadvantage in purchasing cement that the state must bear the responsibility of furnishing satisfactory materials to the contractor, and when cement fails to pass tests it leaves them in a rather difficult position. The commission believes that the advantages lie largely in the fact that contractors are not obliged to have a large working capital tied up where cement is stored in considerable quantities. It is doubtful whether any thing is saved in the cost, or that any better materials, construction or inspection are obtained.

Michigan furnishes cement largely because it manufactures in its own plants about 50% of all that is needed. The advantages are that it ties up less of the contractors' capital, saves from 2½ to 5c a barrel, permits more satisfactory inspection service.

Missouri furnishes concrete aggregate whenever trouble in deliveries might be anticipated by the contractor. Saves from 10 to 20c per barrel on all cement, but finds as a disadvantage that it tends to reduce the items on which the contractors can figure profits.

Nevada figures that by purchasing corrugated

metal pipe and furnishing it to the contractor it saved $10,985 during the past year. Culvert companies quote lower prices because they receive payment from the state within 30 days after delivery.

Rhode Island furnishes culvert pipe, chiefly to avoid delay, pipe for culverts being ordered well in advance of the awarding of the contract so that they can be made up into proper lengths and the installation stations marked on same. As soon as the contract has been awarded the pipes are ordered shipped, and when they arrive are immediately unloaded by the contractor and deposited at the proper locations along the road. The state furnishes the asphalt, chiefly because it can inspect it at the refineries of the two companies doing business in the state, which are located in Providence, the laboratory engineers making daily tests on the road asphalt in storage and in intermediate tanks. If the contractors purchase the asphalt, they might have it shipped in from outside the state and inspection after it arrives would be necessary.

Washington does not furnish any material to the contractor, but it is its practice to guarantee to the contractor a price on cement at the factory, this being effective for the life of the contract.

Wisconsin purchased cement for three or four years but discontinued the practice two years ago. It was taken up with the idea of economy only, and it was found that the companies did not make any lower price to the state than it did to contractors.

Los Angeles County, California, finds the practice to its disadvantage, since it makes the county responsible for possible damage claims in case the contractor is delayed through non-delivery of the cement, and in many cases contractors were able to obtain cement at better prices than the county could.

Wayne County, Michigan, furnishes to contractors all portland cement, aggregates, metallic and flexible joint materials, contracting during the winter for all of such materials which will be required during the next season's work. It believes that this practice assures, without controversy, the use of the full amount of material required by the specifications; there is very little waste of materials; there is considerable saving in cost; and better materials are obtained, as the county has absolute control of inspection and deals direct with the vendors.

Pittsburgh, Pennsylvania, purchases materials to secure a better price and get prompter deliveries and more satisfactory and more uniform products. Also, it is cheaper to inspect the materials at a few plants than to inspect them with a number of inspectors scattered over a large number of plants.

"So far as this city has gone in adopting the practice of purchasing materials for use in contracts, I believe that the results have fully warranted and justified the adoption of the practice."

Rochester, N. Y., has tried the practice in connection with one sewage disposal plant, for which it furnished cement, and found it successful.

Activated Sludge Disposal Plant at Charlotte

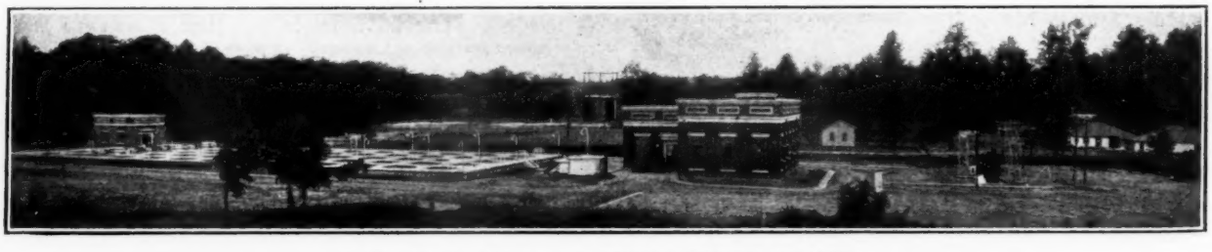
Description of the Sugar Creek activated sludge plant. Sewage is passed through fine screens and preliminary settling tanks before aeration. Preliminary operating results. Use of sludge for fertilizer. Costs.

By E. G. McConnell*

In the July number of this magazine there appeared an article descriptive of one of the two new activated sludge disposal plants at Charlotte, N. C. In this former article it was pointed out that, due to topographic conditions, it was necessary to construct two plants, one for each of the two natural drainage areas, and that these plants were located on Sugar and Irwin creeks at points approximately six miles below the city. It was also pointed out that, though both of them were activated sludge plants, there were so many distinguishing features as to make them unusually interesting especially from the operating point of view.

The important differences are: First, at the Sugar Creek plant the sewage is passed through a fine screen and preliminary settling tank before reaching the aerating units; while at the Irwin Creek plant the raw sewage passes directly to the aerating tanks. Second, at the Sugar Creek plant both fresh and excess activated solids are digested in separate sludge tanks with provisions for the collection and utilization of sludge gas, while at the Irwin Creek plant that excess activated solids are conditioned and dewatered with Oliver filters. The former paper

*Superintendent of Plants, Charlotte, N. C.

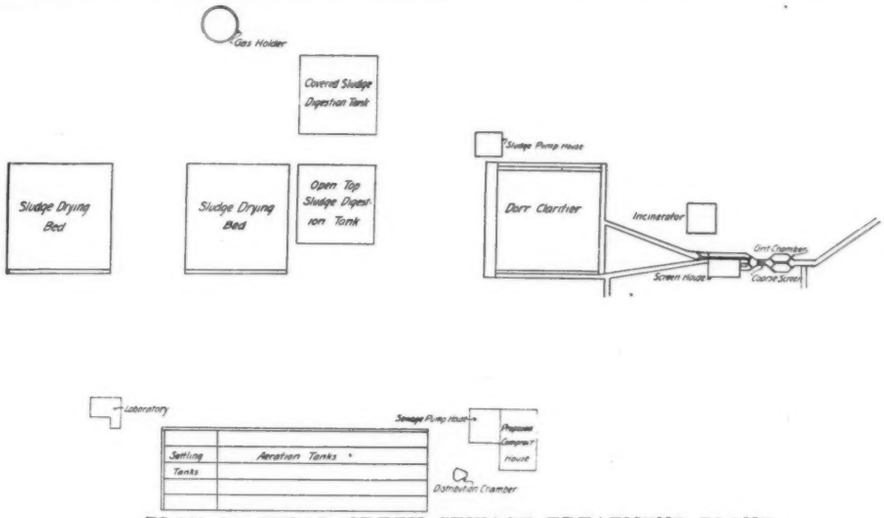


GENERAL VIEW OF SUGAR CREEK PLANT

was confined to a description of the Irwin Creek plant; this paper will be devoted to the Sugar Creek installation.

HISTORICAL

In 1923 Charlotte abandoned some ordinary septic tanks within the city limits and constructed a disposal plant on the site of the present Sugar Creek plant. Briefly, this original Sugar Creek installation consisted of a two-inch coarse bar screen with grit chamber, a Dorr revolving drum fine screen, an incinerator for burning the screenings, a Dorr mechanical settling tank, uncovered separate sludge tanks for digesting the solids pumped from the mechanical settling tank, and sand beds for drying the sludge removed from the digestion tanks. The effluent from the mechanical settling tank was



PLAN OF SUGAR CREEK SEWAGE TREATMENT PLANT

chlorinated and passed to the stream. The degree of treatment afforded by this installation was very limited and during average stream flow conditions the dilution was not high enough to compensate for the incompleteness of the treatment, which resulted in a continual nuisance to the property owners near the plant and along the stream. The plant was a liability from the beginning and finally culminated in a series of damage suits totaling more than one million dollars being filed against the city during 1926. In the spring of 1927 work was started on an activated sludge plant and such parts of the old installation as could be utilized were incorporated in the new plant. This new activated sludge plant has a rated capacity of 5 m.g.d. with a present flow of about 3 m.g.d.

SCREENING

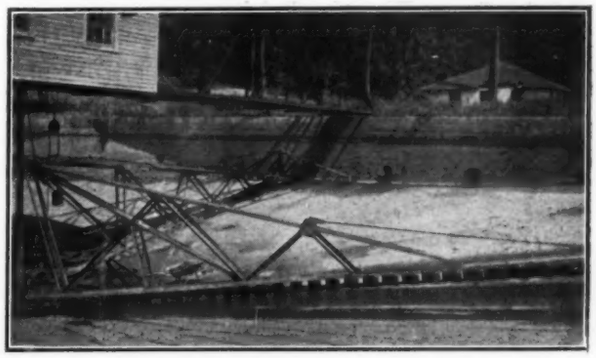
The raw sewage is received through a 36-inch vitrified clay segment-block outfall into the coarse screen channel, where it is passed through a bar screen having two-inch clear openings. This screen is inserted at an angle of approximately 45 degrees into the channel and offers very little obstruction to flow but serves to protect the fine screen from large pieces of heavy material that might cause damage. At regular intervals this coarse screen is raked by hand and the screenings deposited in large garbage cans and taken to an incinerator.

From the coarse screen the sewage passes to a Dorr revolving drum fine screen. This screen measures 6 ft. x 6 ft. and has 3/16-inch by 2-inch slot openings. It is driven by a 3 h.p. motor with reduction gears to give a screen speed of 150 r.p.m. The screenings collect in a pit beneath the screen, from where they are raised at hourly intervals by a motor-driven bucket conveyor and deposited in garbage pails for incinerating. Both coarse and fine screens remove an average of approximately 500 pounds of screenings per million gallons of sewage.

Both incinerator and fine screen are of ample capacity and are operating satisfactorily, but it is proposed to discard them as they are not necessarily needed with the new installation. It is obviously a waste to consume coal to destroy screenings that are largely cellulose and other gas-producing materials which if placed in the sludge tanks, will produce additional gas for plant operation. In addition, there is the fly and odor nuisance produced by having cans of screenings stored until sufficient have accumulated to make incinerating practicable and the objectionable odors incident to incinerating.

PRELIMINARY SETTLING

The preliminary settling tank is the Dorr clarifier of the old installation, which has been remodeled to fit into the new arrangement. It is 100 ft. square and has a capacity of about 500,000 gallons, having a retention of about two and one-half hours at rated plant capacity. Its construction is similar to other mechanical settling tanks of this manufacture. It is driven by a 3 h.p. motor with reduction gears to give a settling mechanism speed of four revolutions per hour. The settled material collects in a sump at the bottom of the tank, from where it is pumped by two motor-driven diaphragm pumps to the digestion tanks. Provision has been made to collect grease and grit in an influent channel which runs the entire width of the inlet end of the tank. The settled sewage passes over a straight flow weir running the entire width of the opposite end of the tank, into a channel, whence it passes across the



PRELIMINARY SETTLING TANK BEING CLEANED

creek through a 24-inch cast-iron pipe inverted siphon which connects to a low-lift pump suction header.

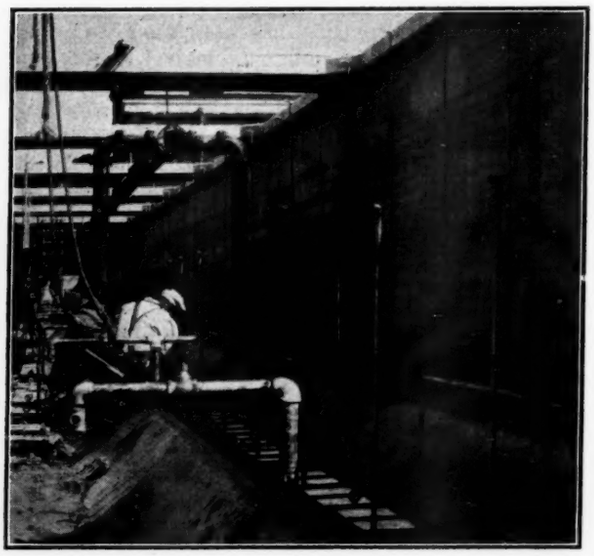
To control the reaction within the digestion tanks, high calcium hydrated lime is added to the fresh solids pumped from the clarifier, using a Gauntt dry feed machine.

PUMPING EQUIPMENT

Three low-lift pumps are provided to raise the settled sewage from the preliminary settling tank across the stream into the aerating units. Two of these pumps are motor driven and one is driven by a gas engine operating on sludge gas. The two motor driven units are 2,000 g.p.m. De Laval pumps operating under a total head of twelve feet. The third pump is similar except that it has a capacity of 3,500 g.p.m. and is driven by a 55 h.p. Sterling gas engine. The pumps are not provided with foot valves and are primed with two No. 5 AA Rumsey vacuum pumps driven by ¼ h.p. motors. Crispin air valves are placed in the priming line next to the pump casings to prevent drawing sewage over into the vacuum pumps after the air has been exhausted.

The pumps discharge through a control valve into a distribution chamber which serves to distribute the flow equally into the five aerating tanks. This distribution chamber is similar in design to the one at the Irwin Creek plant and was fully described in the article devoted to that plant.

The control valve on the pump discharge is specially designed for this purpose and is a very interesting device. A cast-iron box float measuring 24 inches square by 6 inches deep is hinged to a support at the same water level as that in the effluent channel from the preliminary settling tank across the creek. This water level obviously must be maintained at a point to keep the inverted siphon to the pump suction header completely submerged in order to prevent the pumps drawing the suction header and siphon dry. The air contained under this cast-iron float provides buoyancy and the float rises and falls with the water level in the effluent channel. The weight of the cast-iron float actuates a pilot valve which in turn actuates a hydraulic control valve on the pump discharge. This control valve consists of a cone shaped aluminum plug with a base diameter of 18 inches fitting into a bronze ring held in place at the joint of two 24-inch flanged cast-iron tees. This aluminum plug is centered on a 2-inch bronze rod which runs through the axes of the two tees. The two ends of the coupled tees are closed with flanges. The two center openings of the tees form the inlet and outlet of the valve. The bronze rod passes out one of the end flanges through a stuffing box and connects to the hydraulic cylinder which is actuated by the pilot valve. The position of the aluminum cone with reference to the bronze ring determines the degree to which the pumps are throttled to control their discharge. In practice, this device maintains the water level in the effluent channel from the preliminary settling tank within a variation of 6 inches.



BOTTOM OF ACTIVATED SLUDGE TANK, FILTROS PLATES IN PLACE; AIR PIPES AND VENT PIPES

An air lift is provided for raising returned sludge from the return sludge channel to the distribution chamber for mixture with the incoming fresh sewage. There is also provision for introducing the returned sludge into the inverted siphon and raising it along with the fresh sewage with the pumps. This is a much more economical method of handling and will be used if it is found that it will not have any seriously injurious effect upon the returned sludge particles.

AERATING AND FINAL SETTLING TANKS

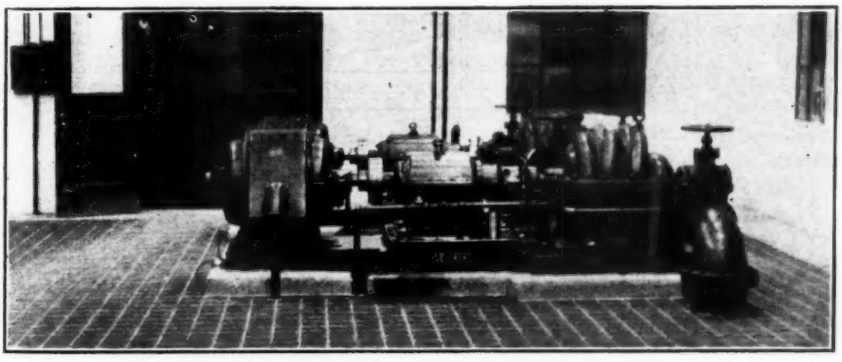
There are five aerating and final settling tanks, similar in design and construction to those in the Irwin Creek plant. Each coupled unit has a rated capacity of 1 m.g.d. Each aerating tank measures 200 ft. x 15 ft. x 11 ft. deep and each final settling tank is 52 ft. x 15 ft. with a sloping bottom varying the depth from 11 to 13 feet. At rated capacity the settling tanks provide a retention period of one and one-half hours. The aerating tanks are the straight flow, ridge and furrow type, provided with filtros plates for air diffusion. The final settling tanks are provided with Link-Belt sludge collecting mechanism for scraping the settled sludge to conical hoppers at the front of the tank, from where it is raised to the surface by hydrostatic pressure. That portion of the sludge that is to be returned and mixed with the incoming fresh sewage passes through a returned sludge channel running the entire length of the aerating tanks to the inverted siphon or the air lift, as desired. The returned sludge is not reaerated. The excess sludge is withdrawn through the excess sludge channel running the entire length of the final settling tanks into an ejector pot, whence it is ejected by a motor-driven Jennings ejector directly to the sludge digestion tanks. The capacity of this ejector is 50 g.p.m., but this capacity may be lowered by decreasing the flow of sludge to the pot, as the ejector is set to automatically trip when the pot is filled.

AIR COMPRESSING EQUIPMENT

Air is furnished to the aerating units by three De Laval three-stage centrifugal air compressors. Two of these compressors have a capacity of 3,000 cubic feet of free air per minute at eight pounds pressure and are driven by 150 h.p. General Electric motors. The motor speed is 1,750 r.p.m., with increasing gears to give a compressor speed of 5,850 r.p.m. The third unit is similar except that it has

a capacity of 3,500 cubic feet per minute and is driven by a 225 h.p. Sterling gas engine. This gas engine has a normal speed of 1,200 r.p.m., with increasing gears to give a compressor speed of 5,850 r.p.m. This gas engine as well as the one driving the sewage pump are the well known Sterling gasoline engines and have been adapted to the use of sludge gas as fuel by merely removing the gasoline carburetors and feeding the sludge gas directly to the engines. By replacing these carburetors and connecting up gasoline lines which are provided (which change takes only a few minutes) they can be operated with gasoline. The compressor engine has a gasoline storage tank of 1,500 gallons capacity, while the pump engine has a tank of 500 gallons capacity. This gives three sources of power available for plant operation.

The air compressors have a circulating oil cooling system with an oil storage of 250 gallons. The oil is cooled by a water jacket containing plant effluent. The gas engines are also cooled with plant effluent. This plant effluent is pumped into a 6-inch cast iron pipe system by a Jennings motor-driven pump with a capacity of 100 g.p.m. under 40 pounds pressure. A fire pump of similar manufacture but



AIR COMPRESSOR AT SUGAR CREEK PLANT

with a capacity of 300 g.p.m. under 75 pounds pressure is provided also. Several fire hydrants are located on the pipe system at strategic points, which serve not only for fire protection but furnish a source of water supply for general plant cleaning purposes. A sanitary water supply is furnished from a deep well equipped with a motor-driven pump and 1,200 gallon elevated tank. This water is also piped to different points around the plant.

METERING EQUIPMENT

The plant effluent is metered with an indicating-registering-recording Venturi meter. The total air output is also measured by an indicating-registering-recording meter. Each aerating tank is equipped with a manometer indicating the air flow and aids in maintaining an equal distribution of air to the five aerating units. All metering equipment is of Builders Iron Foundry manufacture.

SLUDGE DIGESTION TANKS

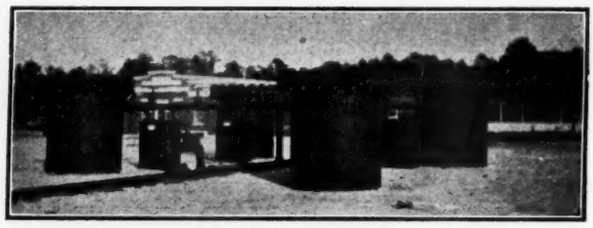
The excess activated sludge, together with the fresh solids removed from the preliminary settling tank, are digested in three covered digestion tanks provided with gas collectors. Each tank measures 73 ft. x 75 ft. and is divided into four equal and separate compartments. Each compartment has a hopper bottom. The straight side depth of the tanks

A THREE-STAGE 3500 C. F. M. AIR COMPRESSOR DRIVEN BY ENGINE OPERATING WITH SLUDGE GAS

is 10 ft., with an additional hopper depth of 9 ft. 6 ins. They are provided with flat reinforced concrete roofs with enough crown for drainage. Two concrete columns 15 inches square support the top over each compartment. Each compartment is equipped with a gas collector for removal of the sludge gas produced during the digestion process. These collectors are three-foot lengths of 24-inch cast-iron flanged pipe inserted into the roofs of the compartments. In each collector there is a sludge screen made from a ¾-inch casting 23 inches in diameter and containing sixteen half-inch slots. This screen is supported from a shoulder flange at the bottom of the 24-inch collector. The four collectors for the four compartments of each tank are grouped near the center of the tank. The gas passes out through 2-inch galvanized wrought pipe through an ordinary gas meter from each compartment into a 4-inch gas header pipe which leads to the gas holder. Fresh sludge is pumped to the compartments through a 12-inch cast-iron pipe inlet 3 ft. 6 inches below the surface, and digested sludge is withdrawn through a 12-inch pipe from the hopper. Both sludge inlet and withdrawal lines are well valved from headers to permit pumping into or withdrawing from any one of the four compartments of the three tanks.

A 6-inch overflow removes the displaced supernatant liquid from the surface of each compartment and picks up this overflow at the surface of a 2 ft. square well the sides of which are built up of 1½-inch oak boards six inches wide with edges cut back to allow ½-inch slots. The elevation of the overflow pipe is fixed to allow a two-foot seal and permits the withdrawing of digested sludge without breaking the gas seal and allowing air to enter and mix with the gas. The overflow of supernatant liquid discharges into the inverted siphon and passes through the aerating units.

A gas holder operating under six inches water pressure, and with a capacity of 30,000 cubic feet, stores the collected gas and in turn feeds through gas distribution piping to the laboratory and gas

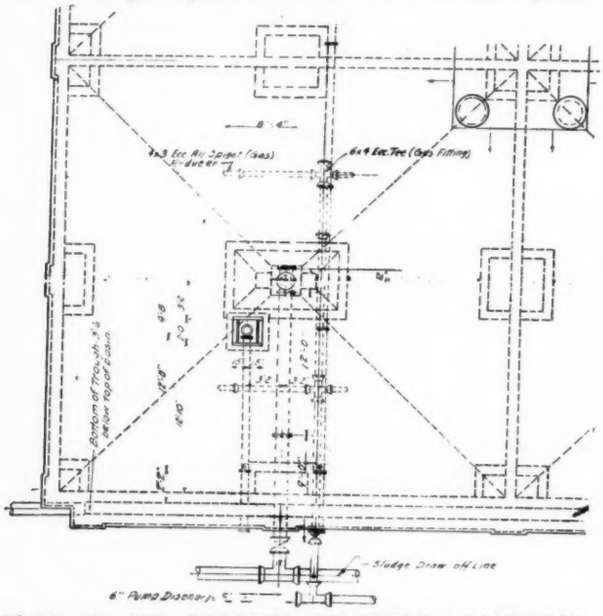


GAS COLLECTORS AND METERS ON ONE OF THE SLUDGE DIGESTION TANKS

engines. Both the entrance and discharge pipe from the gas holder are provided with a drip pot for collecting moisture and minimizing the amount that collects in the piping system.

SLUDGE DRYING BEDS

Two open sludge drying beds which were a part of the original plant installation receive the digested

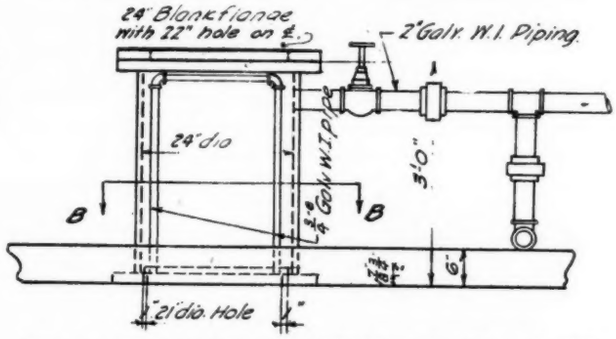


PLAN OF ONE QUARTER OF SLUDGE DIGESTION TANK. TWO GAS COLLECTORS ARE SHOWN AT THE UPPER RIGHT CORNER

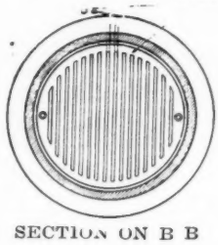
sludge from the tanks. Each bed is 100 feet square and contains 8 inches of stone and 6 inches of sand. The bottoms of the beds are drained with drain tile which discharge into a channel at the end of each bed. The drainage is ejected from this channel by a Jennings ejector back to the digestion tanks. The dried sludge is removed by hand and loaded on to farm manure spreaders and scattered upon nearby farm lands for fertilizer.

GENERAL CONSTRUCTION

The new buildings are of first-class reinforced concrete construction. Their exteriors are red tapestry brick trimmed with cast concrete slabs. The floors are red tile with white joints. The interior wall and ceiling surfaces are white enameled and all metal work and mechanical equipment are black enamaled. The office and laboratory are provided with gas connections for heating, and their floors are covered with brown battleship linoleum. Windows are steel sash with factory ribbed glass, those of the office and laboratory being equipped with bronze screens. The old buildings of the original installation hardly come up to this standard and de-



ONE OF THE FOUR COLLECTORS SHOWN IN THE PHOTOGRAPH ABOVE

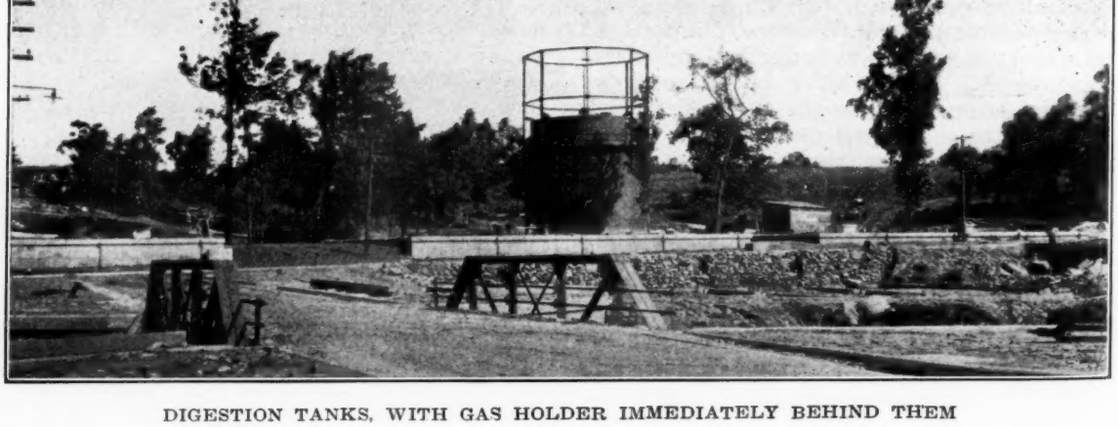


SECTION ON B B

tract somewhat from the appearance of the general layout. These old buildings are constructed of solid wall common brick and have composition shingle roofs. Twenty-foot curbed driveways surfaced with a mixture of sand and clay surround the buildings and tank structures. A steel highway bridge spans the creek. Concrete sidewalks are provided between the buildings.

OPERATING EQUIPMENT

The laboratory is perhaps one of the best equipped sewage plant laboratories in the country. Com-



DIGESTION TANKS, WITH GAS HOLDER IMMEDIATELY BEHIND THEM

plete facilities are available for sanitary and bacteriological work. Both gas and electric power are available for heating purposes. A glass-enclosed fume hood is built-in with the tables for removing objectionable odors or fumes. The table tops are alberene stone.

The dried sludge handling equipment consists of two 70-bushel International farm manure spreaders and a team of mules. A 1½-ton Ford truck is available for general drayage.

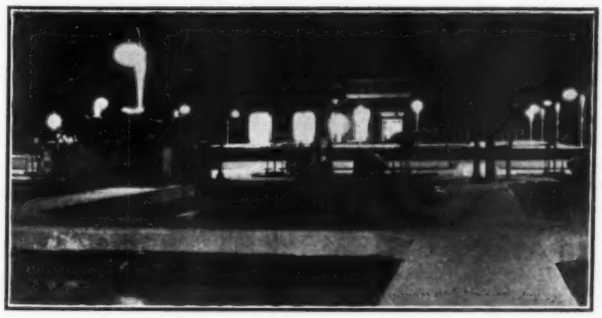
PRELIMINARY OPERATING RESULTS

The plant has been in operation approximately four months and it is, therefore, a little early to make any definite statements as to operating results. Considerable difficulty has been encountered with the bulking of sludge in the aerating and final settling tanks. This is attributed to the overflow from the sludge digestion tanks being passed through the aerating units. Certain trade wastes evidently encourage this bulking. Though the digestion tanks are maintained in a satisfactory stage, the liquors displaced from them during pumping periods are at best a very unsatisfactory addition to the aeration tanks. Experimental work is now being done to determine if this overflow cannot be taken care of in some other manner that will fit into the local layout and conditions. The principal injury resulting from this bulking sludge is that large flocculent particles come over the final settling tank weir with the plant effluent and the increased amount of air required to bring the units back to normal. Apparently the bulked sludge does not interfere with proper digestion in the sludge tanks. If the excess activated sludge from this plant were being conditioned and dewatered, as is the case at the Irwin Creek plant, it is extremely doubtful if satisfactory results could be effected.

The mixture of fresh solids and excess activated sludge digests readily in the sludge tanks with the reaction maintained at from pH 7.1 to pH 7.6. It is proposed to attempt the digestion of excess activated sludge alone in one of the tanks, to determine if such can be done with reasonable gas production; and if so, it is proposed to eliminate preliminary sedimentation.

No accurate estimate can at present be made as to the amount of gas produced per capita, but it is evident that it will be around one-half cubic foot per capita daily. The gas engines operate exceptionally well on the gas and this source of power materially reduces the power costs for plant operation.

To date, all the sludge removed from the tanks to the drying beds has been removed from the beds without cost to the city, by farmers in the vicinity of the plant, who use it for fertilizer. It is anticipated that it will be valuable for local lands on account of its lime content and that it will soon be possible to place a market value upon it and make it a source of revenue.



NIGHT ILLUMINATION, SUGAR CREEK PLANT

Following are some laboratory results for the past three months:

	Suspended Matter		Dissolved Oxygen		B. O. D.		Stability of Effluent
	Inf.	*Eff.*	*Inf.*	*Eff.*	*Inf.*	*Eff.*	*Days*
July	188	43	0.0	3.0	191	41	5 Plus
August	235	25	0.0	3.5	127	15	5 Plus
September	220	33	0.1	3.5	140	17	5 Plus

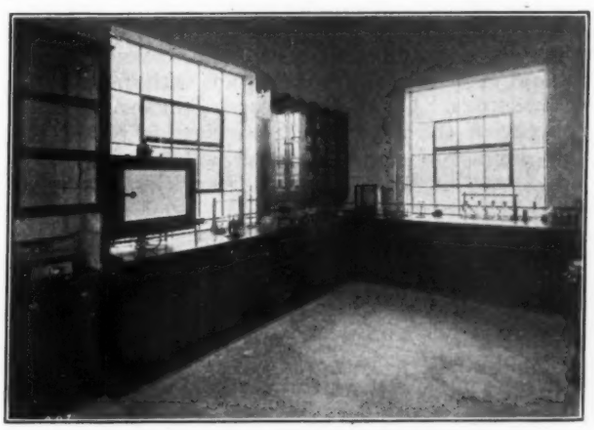
(Results expressed in parts per million)

OPERATING PERSONNEL

The operation of the disposal plants is under the general supervision of the Commissioner of Public Works. Both disposal plants as well as the water filtration plant are directly in charge of the superintendent of plants. There are three eight-hour shifts of one operator and two helpers. The day operator is general foreman and looks after all operating details. A chemist does all the laboratory work. In addition to this force, it is often necessary to employ two extra helpers for a few days to aid in removing sludge from the drying beds.

LABORATORY ROUTINE

An excellent record of daily determinations is being compiled and, together with plant operating data, recorded upon monthly operating sheets. All determinations are made daily and are for suspended solids, temperature, hydrogen-ion concentration, dissolved oxygen, oxygen demand, stability and bacteria in the influent and effluent. In addition, each aerating unit is run daily for thirty-minute settleable solids, dry solids, and hydrogen-ion concentration, and the plant effluent is run for nitrites and nitrates. The creek above and below the plant discharge is run for suspended solids and dissolved



A CORNER OF THE LABORATORY

oxygen, with weekly determinations of oxygen demand. A careful check of the reaction within the sludge digestion tanks is made daily.

The operating costs for the entire plant are approximately as follows per month:

Power (106,000 k.w.h.)	$1,600
Labor and superintendence	1,035
Chemicals (lime)	160
Repairs	50
Supplies	35
Miscellaneous	25
Total	$2,905
Cost per M. G. (3 m.g.d.)	$32
Adding fixed charges:	
$307,000 @ 6%	$1,535
	$4,440
Cost per M. G. (3 m.g.d.)	$49

The following firms were awarded the contracts for the construction work and the major items of equipment:

General construction contract—A. H. Guion Company, Gastonia, N. C.

Electrical construction contract—Harrison-Wright Co., Charlotte, N. C.

Sewage pumps—De Laval Steam Turbine Co.

Effluent pumps—Nash Engineering So., Norwalk, Conn.

Air compressors—De Laval Steam Turbine Co.

Gas holder—R. D. Cole Mfg. Co., Newnan, Ga.

Sludge collectors—Link-Belt Company.

Cast-iron pipe—Glamorgan Pipe & Foundry Co.

Meters—Builders Iron Foundry.

Valves—Grinnell Company.

Laboratory equipment—Fisher Scientific Co., Pittsburgh, Pa.

The plant was designed and its construction supervised by William M. Piatt, consulting engineer, of Durham, N. C. P. D. Davis was assistant engineer and H. P. Fedding was resident engineer. Construction work was carried forward and the plant is now operated under the general supervision of Hon. Robert L. Brown, commissioner of public works; the other members of the City Commission being Hon. F. M. Redd, mayor, and Col. W. R. Robertson, commissioner of public safety. The writer is superintendent of plants, and A. Wayt Thomas is city engineer. E. G. Grigston is general foreman, and the plant is directly in his charge.

Recent Developments in Water Purification*

Concerned with processes rather than new types. Mechanical clarifiers. Mixing facilities. Aeration. Filters. Coagulants. Chlorination. Softening.

By Wellington Donaldson†

In determining the significance of changes or innovations in water-works practice, there is much latitude for individual judgment. Changes may represent merely fugitive experiments on the one hand or on the other hand may be destined to find a permanent place in development of the art of water purification. The water-works field is a wide one: local conditions are quite diverse; modifications of processes considered highly advantageous in one locality are wholly inapplicable in another where the character of water or other local conditions are different. In this paper the author will attempt to indicate briefly his personal reaction towards those recent changes in established practice which seem to him to possess the greatest general interest.

Speaking generally, the most notable recent advances have been concerned with processes or modification of processes rather than with new types of structures. Of the structural changes noted in a survey of the more recent purification plants, the most important are concerned with mechanically-cleaned settling basins, mixing facilities and aeration.

MECHANICAL CLARIFIERS

Originally developed as a metallurgical process, the mechanical clarifier has been finding increased favor in water-works practice. Its first point of entry into water-works practice was in connection with softening plants where the voluminous precipitate produced by lime and soda reactions indicated advantages through continuous removal of sludge, in contrast with usual practice of intermittently emptying and flushing the settling units. The mechanical clarifier, at first circular in plan with crescentic inlet and outlet troughs, has developed into a square plan having more efficient settling characteristics. The early installations were separate independent structures. The tendency now is to incorporate the clarifier in one end of a rectangular settling basin, the two structures being integral and with a continuous water surface.

The first mechanical clarifier installation of record in connection with municipal water works was at Benton Harbor, Mich., put in service in 1923. At the present time the mechanical clarifier has been incorporated in the design of some 14 water softening plants, chief among which are Newark, O.; Piqua, O.; Springfield, Ill.; Miami, Fla., and South Pittsburgh, Pa. The efficiency and economy of these devices in comparison with the older style settling basins are not yet fully established, but their popularity would indicate that mechanically cleaned basins of some type are likely to find a permanent place in connection with water softening.

The utility of the mechanical clarifier for removal of the sludge from softening reactions has more recently been extended into other water purification fields. At Lancaster, Pa., and Decatur, Ill., clarifiers are used to serve in place of ordinary coagulating basins. The latest adaptation is a preliminary sedimentation device for the very turbid

*Paper before the 47th Annual Convention, New England Water Works Association.

†Of Fuller & McClintock, New York City.

waters of the middle west. The Missouri river, for instance, has an established peak of 15,000 ppm., or 62 tons of dry suspended solids per million gallons; while 5,000 to 8,000 is not an uncommon occurrence during the spring and summer months. The customary practice on the Missouri and other muddy western rivers has been to provide extensive preliminary sedimentation in simple rectangular basins. The large amount of sediment deposited in these basins has necessitated putting them out of service frequently for a cleaning, with considerable inconvenience to operation and cost for labor and flushing water. These facts have led to the idea of continuous removal of the deposited sediment in a more satisfactory manner than can be obtained by well sloped or underdrained bottoms. The result has been an incorporation of mechanical clarifiers in at least two of the important mid-west plants. The Kansas City, Mo., plant which went into operation in June of this year has four 200-foot diam. circular clarifiers as preliminary sedimentation units. The new Missouri river plant of the St. Louis water works now under construction includes five 150-foot square clarifiers for preliminary sedimentation ahead of the softening processes. Operating results are not yet available at Kansas City under normal conditions to give a comparison with plain rectangular basins as to efficiency of removing suspended solids and operating costs. Until these points have been settled, it is fair to regard the matter as in an experimental state in so far as these two installations may have a bearing on influencing practice in handling excessively turbid waters. They at least constitute a notable modification over the customary plant layout.

MIXING FACILITIES

Another feature of the filter plant layout which has been undergoing extensive modification within recent years, is the mixing arrangement for facilitating the chemical reactions connected with softening or coagulation. The lack of flexibility of the older baffled type of mixing chamber for varied conditions of flow is well recognized and has led in recent years to experimentation with other types of mixing devices, though as yet no standard design has been evolved. The Topeka softening plant has a loosely baffled chamber with mechanical stirrers. Many of the recent softening plants employ single circular mixing chambers with mechanical stirrers. The Sacramento, San Leandro and Beverly Hills plants employ multiple circular mixers with paddle stirrers, operated in tandem. Knoxville, Tenn., is another recent example. The plants at Providence, R. I., Watertown, N. Y., Albany, N. Y., and Danville, Va., have circular mixing tanks without mechanical stirring devices, the tangential bottom inlets and tangential top outlets being relied upon to produce stirring velocities. The Kansas City and St. Louis works have somewhat similar mixing devices, with the difference that the tangential inlet is at the top while the outlet is at the center of the cone shaped bottom. The flow is thus downward in a vortex.

Still another notable type is the "hydraulic jump" installed in the new 165 mgd. Fairmont filter plant at Cleveland. The same feature is incorporated in plants at Bay City, Mich., Port Arthur, Tex., Hannibal, Mo., Lake Charles, La., and Hamlet, N. C. Most of these newer types of mixing devices appear to be working satisfactorily, with advantages over the older types.

AERATION

Prior to the general adoption of filtration, aeration was regarded as an effective weapon for combatting odors and tastes in stored waters. Later the marked benefits derived from filtration somewhat obscured the advantages of aeration and many representative filter plants, built a few years ago, were provided with meager or no facilities for aeration. More recently, however, there has been a recrudescence of the aeration idea as water consumers have become more critical of the physical qualities of the supply. In several instances aeration of both raw and filtered water is practiced.

Aeration is now employed for other than the original purpose of overcoming tastes and odors due to plankton growths or the effects of stagnation in stored water. Certain classes of trade waste responsible for taste and odor respond favorably to aeration, though others do not. At West Palm Beach and a few other places, addition of the alum dose prior to passage of the raw water through spray nozzles has been found distinctly helpful in promoting coagulation of a soft colored water. At both Richmond, Va., and Rahway, N. J., it has been found that spray nozzle aeration is quite effective after substantial prechlorination doses in reducing residual chlorine to within non-troublesome limits. Another use for aeration which has come to the front, is its ability to lower the carbon dioxide content, thereby decreasing aggressiveness of the water. This has led to the use of the so-called effluent aerators as exemplified by the plants at Albany, Providence, West Palm Beach and Poughkeepsie.

That the aeration feature, aside from its utility, can be made to serve an ornamental purpose is shown very well by the Kensico and Ashokan installations of the New York water supply, and those at Providence, West Palm Beach and the San Leandro plant of Oakland.

In general, where the need of aeration is plainly indicated, the tendency has been towards the use of fixed spray nozzles in preference to other devices which are not so completely effective. Mention deserves to be made, however, of the floating nozzles in the Sacramento and Breverly Hills installations. In the latter, the released hydrogen sulfide gas is captured and discharged through a tall stack to avoid complaints in a high-class residence district.

FILTERS

No important changes in filter design have come to the front recently. There still exists considerable diversity of opinion as to the merits of various styles of underdrain systems; none of them is perfect and most of them are satisfactory. Of the filter appurtenances such as gages, controllers, etc., new designs have appeared within the last year or so, but nothing particularly novel has developed, excepting the substitution of electrical instruments at Wausau, Wis., for the usual filter flow gage. It seems to be merely a question of healthy competition among the manufacturers.

It is worth noting here the revival of the old Hyatt idea of washing a filter bed by sections instead of as a whole. It will be remembered that some of the early New York Continental filters employed the "quadrant" wash for a single undivided bed, but the idea fell into disuse. It has been revived in a modified form in some of the recent plants for washing beds made up of separate bays; for instance, at Poughkeepsie and West Palm Beach, where the four bed sections are washed independently, and at the San Leandro, Calif., plant where the filter is washed by halves. The purpose obviously is to reduce the size of wash piping required and the demand rate of wash water.

COAGULANTS

Much experimentation is continually being carried on in various parts of the country to discover coagulants better suited than is ordinary filter alum to certain types of water and to decrease the cost of the preparatory treatment. These experiments have dealt mostly with some form of sodium aluminate under various trade names, usually supplementary with alum. Results reported in some places are distinctly favorable, but in others the trials have shown no advantage either as to efficiency or cost over the customary treatment.

The repertory of water treatment chemicals is continually increasing. From Elizabeth City, N. C., comes a report of the successful use of chlorinated copperas as a coagulant for a soft, highly colored (550 ppm.) swamp water after comparison with alum and sodium aluminate as a primary coagulant. The treatment is carried out by simply feeding chlorine to the copperas solution delivered by a dry feed machine.

CHLORINATION

The chlorination of water has expanded considerably. In addition to the common practice of applying the chlorine in a single dose to the plant effluent, many plants are now making use of split treatment, or application at two points. The practice is not uncommon of treating both raw and filtered water where heavy bacterial loading exists. In this case, application to the raw water is usually referred to as "pre-chlorination." Hackensack, N. J., is a recent convert to this practice, about 0.5 ppm. being used as a primary dose to the inlet of coagulating basin and a second dose of 0.15 ppm. being given to the filter effluent. At Toledo, O., the filtered water is treated twice to secure satisfactory bacterial results. In Richmond, Va., split or double chlorination is practiced in order to keep down algal growths in a shallow exposed clear-water basin of considerable area. At Kansas City, Kan., a second application of chlorine is used to control algal growths in a distributing reservoir.

Another important use for chlorine is the so-called superchlorination process, whereby an unusually large dose is applied for the purpose either of overcoming extraordinary pollution or the destruction of obnoxious substances such as phenols, which the water supply may contain. This method involves a secondary application of sulfur dioxide or other anti-chlor for reducing the excess chlorine, which would otherwise cause taste. It should be pointed out that super-chlorination is directed primarily to the destruction of taste and odor-producing substances, which are not removed by the familiar processes of coagulation and filtration. In somewhat the same category, but widely different in principle, are the Cleveland experiments for removing taste and odor by filtration through a special activated carbon. So far as the writer is aware, super-chlorination, first exploited in this country by Howard at Toronto, is now used on a routine basis only at Rahway, N. J.

SOFTENING

The last few years have witnessed notable additions to the list of softened municipal supplies in this country. Advances in this art have been due, as C. P. Hoover has pointed out, to the recarbonation feature which not only obviates the grief from incrustation, but gives effective sterilization and enables more complete softening to be carried out than hitherto possible by the lime-soda process, and at a lesser cost. Simpler and more dependable methods of recarbonation have been developed. The pneumatic system of handling lime as used at Springfield, Ill., gives promise of modifying the older mechanical conveyor method.

As regards zeolite softening, there are now seven installations in service for municipal water supplies in this country. With the exception of the 4 mgd. plant of the Ohio Valley Water Co. at McKees Rocks, the installations are all quite small, ranging from 40,000 to 200,000 gallons per day capacity. However, the extreme hardness of the water handled by some of them is notable.

The 2 mgd. plant at Sewickly, Pa., now nearing completion, is notable for being constructed along lines of ordinary rapid sand filters. In other words, reinforced concrete replaces the steel shell construction found in the other municipal installations.

Modified methods of washing and regenerating the zeolite filter have come to the front, but in these it is not easy to distinguish between merit and salesmanship. From the published results, however, it appears that the McKees Rocks plant has succeeded in reducing materially the all-important salt ratio. It is interesting to note that a few industrial zeolite installations are reported to be using sea water or oil well brine for regeneration.

CONCLUSION

As stated at the outset of this paper, the matters which have occupied the attention of water-works people lately are not so much new design features as the modified use of purification facilities already available along the line of coagulation, softening and chlorination. The indications are that treatment of water, instead of being simplified, is becoming more complex and more highly specialized. The standards for hygienic safety have for some years been fairly well met. Now there is beginning to come to the front more prominently than ever before the expectation that public water supplies will not only be free from danger to health, but shall be agreeable in their physical properties and reasonably low in hardness or other chemical constituents which affect their use not only by domestic consumers but by industries as well. How else can we interpret the refinements now taken for maximum color reduction, for taste and odor control, and the growing demand for softer water?

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CONTENTS

Practical Suggestions on Sludge Digestion

We have, during the past year, published results from extensive experiments on the digestion of sewage sludge and the effect thereon of bacteria, heat, pH valvues and other affecting conditions, which have unquestionably advanced the science of sewage treatment. To some superintendents of plants, the experiments and the conclusions therefrom may have seemed too theoretical for practical use by them. We are glad, therefore, to be able to supplement them by practical suggestions on operation given by a man who for fifteen years has been one of the leading sewage plant operators of the country, and who has also been connected with the experimental station conducted at the Plainfield sewage plant.

Mr. Downes, in a paper in this issue, gives a number of suggestions on the operation of Imhoff and separate digestion tanks, with utilization of gas, which should be of value to all superintendents and engineers who are in charge of such types of treatment, since they are made by a practical man who has given years to the operation and study of such types and whose standing as a sewage plant operator is unquestioned. "Notes on Practical Sludge Digestion" on page 423 of this issue, should be read by all who are in any way interested in sewage treatment plants.

Toll Roads and Toll Bridges Returning

At the beginning of this year, there were in operation in the United States 233 toll bridges, of which 191 were privately owned; and since then construction has been begun on 29 new ones, while 163 are proposed. Of the 233, 86 were built within the last ten years.

These bridges are in most cases important traffic carriers, the majority of them being a part of the Federal Aid highway system, and 60 others being on state highway systems.

In an article in this issue, the subject of toll bridges and toll roads is discussed, and it appears that the number of the latter is increasing as well as the former. For a number of years the idea was very unpopular, it being argued that roads were for the use of all citizens, or to bring to the cities outsiders who had business with the merchants or other tax payers and who should therefore be encouraged to use them rather than discouraged.

The automobile has been held responsible for most changes having to do with traffic conditions, and is probably responsible for this also. For the majority of car users now are out for pleasure to themselves rather than for business, and should therefore, it may be argued, pay in proportion to their use of roads and bridges. The popular gasoline tax is based on this principle—that the roads should be paid for by the direct users of them in proportion to such use.

With the increasing number of cross connecting and feeder roads, operating highways as toll roads becomes increasingly difficult; but with universal taxing of gasoline for highway purposes and the

increasing number of toll bridges, we seem to be experiencing a return to somewhat of the principle of the toll road of our grandfathers' day.

More Waterborne Typhoid

A city in western New York has just suffered an epidemic of typhoid, resulting in 3 deaths and 164 cases. This was preceded by two epidemics of gastroenteritis, involving about 3,500 cases, which directed suspicion to the water supply. According to the New York State Department of Health, the cause of the outbreak has been traced to a break in a submerged pipe running from an emergency supply to the pumping station, which allowed raw river water to be pumped into the mains. The amount of chlorine added was insufficient to protect against this gross pollution.

Emergency and auxiliary supplies of doubtful quality are always dangerous. The chain is no stronger than its weakest link. Few cities can afford to have doubtful water supplies. One of the best investments a city can make is provision for an adequate and safe-at-all-times water supply.

Contractor's Views on Specifications

Specifications are a matter of the greatest possible interest to a contractor, for he makes his living solely by carrying out the provisions of them. However, the contractor's viewpoint is entirely different from the engineer's viewpoint, said Henry M. Roberts of the J. Fred Roberts Construction Company, at a recent highway conference at the University of Colorado. According to Mr. Roberts, "he is most vitally interested in two things; clearness, and another attribute which cannot be described in one word."

He is not especially interested in the mix of cement or other features of the contract dealing with the quality or quantity of work to be done, so long as he can understand exactly what that quality and quantity are. "The fundamental legal conception of a contract is that it represents a meeting of the minds of the contracting parties. Specifications should possess such clearness of statement of intent and such freedom from ambiguity that, as far as is humanly possible, a meeting of the minds is achieved. If a reasonable meeting of the minds is not achieved when the contract is signed, the contractor is likely to be the chief sufferer later on."

The second attribute he describes as "adequately diversified unit classification of quantities." He illustrates his idea by referring to the extensive changes in specifications which took place in Colorado three years ago. Classified structure excavation was introduced; overhaul was specified on borrow excavation and on gravel surfacing material; the free haul limit in figuring overhaul was reduced from 800 to 300 feet. Each of these changes was advocated by the contractors, and each tended to reduce the hazard. Each had the effect of reimbursing the contractor more nearly in proportion to the expense undergone in doing the work. Even the reduction of the free haul limit helped to draw a line of demarcation between the job having an average haul of 600 or 700 feet, and the side-borrow fresno job, and to pay the contractor accordingly.

"All these changes indicate an increasing tendency to reimburse the contractor in proportion to the expense he actually undergoes in doing the work. Likewise, they indicate a decreasing tendency toward paying him in proportion to the expense he thinks he will undergo before he starts the work."

Mr. Roberts then discussed the responsibility of the engineer to the contractor, which he stated increased or decreased with the authority given him by the specifications. Concluding, he stated: "The writer is happy to be able truthfully to say to this gathering that it is his belief that, in general, the engineering profession accepts its implied judicial responsibility to the contractor in a most creditable and satisfactory manner, although there have been isolated and infrequent cases when he has felt that the impartial standard of the supreme bench has not been quite achieved."

Airplane Surveying in Canada

According to A. M. Narraway, of the Topographical Survey of Canada, that country has attained leadership in aerial surveying; having, during the past five years, photographed more than 200,000 square miles of country inacessible for ground surveying but rich in natural resources. This made possible completion of a national map of Canada. Approximately 172,000 photographs were taken, of which 50,000 were added during the past year.

In addition to this surveying, planes are used for fire protection, approximately 200,000,000 acres of forested land being kept under observation from the air for this purpose.

Sanitary Engineering Five Thousand Years Ago

Sir Arthur Keith has described sanitary appliances discovered in the recently excavated city of Mohenjo-daro, situated on the west bank of the Indus fifteen hundred miles from Babylon, which is believed to be more than 5,000 years old. The buildings had bath rooms with well laid floors and latrines occupying recesses in the walls. Vertical pipes led the effluents from the latrines to drains laid underneath the house floors. Water chutes were cut in the outer walls of the houses, and a large sewer was laid along the street to carry away the sewage. This sewer was built very solidly, had an even gradient, and the top was arched with corbeled brick.

Sewer Cleaning in St. Paul

During the year 1927, 49,776 lineal feet of sewers were flushed with fire hose in St. Paul, requiring 4,750,000 gallons of water. The Water Department was reimbursed on a basis of 40c per hour for 459 hours, the time hydrants were open during the flushing. The charge of 40c per hour was based on an average of meter readings taken at various hydrants in that city.

Toll Roads, Bridges and Parking Privileges

Fifty years ago, toll roads and toll bridges were quite common throughout the country, but during the past fifteen to twenty-five years it has been the practice in a number of states to endeavor to eliminate these entirely, in many cases by the purchase by the state of such road or bridge and opening the same to free use by the public. Recently, however, there has been evidence of a tendency to return to the idea of making direct charge for the use of roads and bridges, although with considerable variation from the original toll road or bridge idea.

For example, the Alabama Legislature in 1927 authorized an incorporation by the Alabama Highway Director, the president of the State Board of Administration, and the chairman of the State Tax Commission, for the purpose of constructing bridges over navigable streams on the connecting highways of the state. This corporation was authorized to build and maintain fifteen bridges, with approaches, at locations designated by the State Highway Commission, and to issue notes or bonds of the corporation to the extent of $5,000,000 to raise funds for building these bridges, and to pledge the bridges to secure their payment. The corporation was authorized to collect tolls, the sums collected to be used for maintenance and for the retirement of the notes or bonds. When the cost of all the bridges authorized has been repaid, the bridges shall become free bridges and be maintained as part of the state highway system. This law was held constitutional by the Supreme Court of Alabama in the Spring of this year, and it is expected that lettings of the structures and approaches will be made before the end of 1928. The bridges will be of a standard design, approved by the State Highway Commission, the bridge engineer of the commission, H. H. Houk, having charge of the work for the corporation.

The traveling public will be called upon to pay by tolls only the actual interest and sinking fund and maintenance cost of the bridges; and probably not all of this, as the act provides that the interest on the bonds may be paid out of the residue of the receipts from the gasoline tax.

In several cases in the East, very costly bridges have been built by private corporations, the charters for which provide that after a certain period or under certain conditions, the bridges shall become public property and free of toll. An illustration of this is furnished by the memorial bridge across the York river, connecting Yorktown, Va., with Gloucester Point on the northern peninsula; which structure is being financed by Highway Bridges, Inc., and is to be constructed by the McClintic-Marshall Co., borings for the foundations now being under way and it being expected that the foundations will be started before the end of this year. (An interesting feature of this bridge is that the two piers supporting over the main channel a cantilever span with an overhead clearance of 135 ft., are to be built in over 80 ft. of water.)

Private toll roads have been recommended by John N. Mackall, chairman and chief engineer of the Maryland State Roads Commission. Mr. Mackall believes that "it is inevitable that additional, parallel, high-speed motor vehicle roads must be developed between the great centers of population." It will not be practicable to develop these to any great extent along the present rights of way, but new rights of way must be obtained, and this will be the major consideration in the planning and construction of these parallel auxiliary routes. "Before the right of way can be established, and often optioned, legislative authority must be obtained and with this legislative authority will come greatly increased theoretical values of the properties to be acquired. Private individuals, on the other hand, can option and in many cases secure the land necessary for the construction of these roads without a great deal of public notice and they can even acquire excess land which can be developed or sold, to materially reduce the cost of construction."

Mr. Mackall, therefore, believes that such roads obviously can and should best be established as toll roads, and further, as privately owned toll roads. "Assuming," says he, "that private roads are going to be fairly administered and property acquired at fair prices, recapture clauses in the franchise will make it possible for the public to acquire these roads for toll operation whenever it seems desirable. An adequate and fair return should be guaranteed to the investors, or the necessary capital cannot be attracted for the purpose. The question most naturally asked in this connection is, why these roads should be established as private toll roads when such existing roads have all been acquired, largely because of public demand. The difference seems quite obvious. Roads are government. The public is entitled to a good travelable road as a part of government, but the establishment of high speed automobile boulevards is more than government. It is giving to the automobile a sense of luxury and the ability to make much greater use of the road than otherwise, and the motorist should be willing, and in the writer's opinion is willing, to pay a fair toll for this added privilege. At no time do I believe toll roads should be authorized or constructed unless and until public roads already constructed, or to be constructed, have shown their inability to carry the specialized traffic which goes over them. As a matter of fact, on the Atlantic seaboard there are many places today where privately or publicly owned high speed toll roads would attract sufficient traffic to pay interest and construction costs on such roads."

Mr. Mackall also believes that all automobilists should be required to pay for parking space; but in this case, he recommends public rather than private ownership of such space. Said he, "We are not going to get anywhere by providing parking spaces in the buildings for the tenants of these buildings, for the simple reason that the space necessary for automobile storage is the most desirable and the most profitable part of any building. We are not going to widen the streets in the congested parts of our cities and towns; we cannot do it without entirely rebuilding the cities. . . . The problem, then, seems to be to provide spaces for automobiles to park. Obviously this can be done more economically by the municipality than by individuals. . . . Public garages built and operated by the city would, first,

be exempt from taxes, and secondly, money for financing could be obtained at approximately 4% as against 6% for private individuals. The city, with its right of eminent domain, can acquire by condemnation or otherwise property most desirable for garage purposes. If every city would provide at cost garage space to all those who desired to use it, it could then with propriety say to its citizens that you must place your automobiles off the public streets in the garages we are providing at cost, and if you cannot afford to pay that, then you must leave your automobile outside the congested district.

"The only thing, then, that it would actually cost the city to provide these parking spaces would be the loss of taxes on the property used for the purpose. Indeed, in many cases the city owns and is using for other purposes properties within the congested district which could be converted into garages, and the buildings used for garages in conjunction with their present use."

Toll Roads for England

Lord Askwith, who is at the head of one of the syndicates undertaking the project, has given details of a scheme by which motor speed roads would be constructed in various parts of England with the object of speeding up motor transport. A syndicate called "Motor Roads, Limited" proposes constructing a motor speed road between London and Brighton as an experiment, provided the necessary powers can be obtained from Parliament. This road would be of concrete with two separated lanes, one for up and one for down traffic. It is estimated that it would cost about $15,000,000. Toll would, of course, be charged for the use of the road. If this should prove successful, it is proposed to build similar roads from London to Portsmouth and London to Southampton, each to cost about $30,000,000. There would be no grade crossings and no speed limit on these roads.

The London Morning Post states that it understands that the official view of the Ministry of Transport is that the present national roads have not nearly reached the saturation point and that it would not be economical to build a $15,000,000 motor road to Brighton for the sake of relieving such additional traffic as is experienced on fine week-ends and on national holidays. It also doubts whether sufficient money could be raised to build the road and whether a charge per mile would not eventually prove a bigger tax than the majority of motorists would be prepared to shoulder in addition to the motor taxes and gasoline duty already in existence. "Meanwhile," states the U. S. Department of Commerce, "$125,000 is being collected from various interests to facilitate the passage of the bill through Parliament next session."

New Mexico Road Notes

Twenty-five different road projects, the largest 26.1 miles long, are now under construction in New Mexico. The cost of these will exceed $3,000,000. The work ranges all the way from dirt grading to concrete pavements, with both timber and steel bridges in the list.

Figures compiled by the bridge division of the State Highway Department show that since the beginning of the present bridge program in January, 1927, over a million dollars of Federal Aid bridges have been built or are under construction. This does not include bridges built by the Highway Department itself, which are not contracted. Twenty-two of these bridges are of all creosoted timber construction, two are all concrete construction, eight are timber on concrete substructure, twelve are steel on concrete substructure, and one is a combination of creosoted timber, steel and concrete. Three of these bridges cost in excess of $100,000. These are large figures for a state with a population of only 390,000, including Indians and natives, and 30% of whose land is non-taxable.

The Highway Commission has recently inaugurated a new practice in connection with highway curves. These were previously designed on the basis of a traffic speed of 20 miles per hour, while the new regulation calls for a basis of 35 miles an hour. Another change is in connection with the side slopes to the ditches. These were formerly built on a slope of three feet horizontal to one vertical, which, although fairly safe, has been changed to four horizontal to one vertical. It is believed that with the flatter slope, if a driver should find it necessary to go off the shoulder into the ditch he may drive down and back again with little danger to car and occupants.

August Hail Blocks New Mexico Road

The New Mexico State Highway Department has reported a freak storm in that state last August. A hail storm came on suddenly and with such intensity that the hail flowed down the road onto a bridge, where it collected in a solid wall from rail to rail, blocking traffic. According to the department "Tractors and graders were called out to break through, hand efforts failing."

Two-Course Concrete Roads in New York

Nearly all of the proposals for roads in the Buffalo district of New York State this year have required the construction of concrete pavements with gravel tops, to be laid in two courses. The standard specifications of New York State require the use of stone in all concrete pavements, except where a permissible note is written on the plans that gravel may be substituted for stone. The experience of the engineers in the Buffalo district is that a high-class gravel makes at least as satisfactory if not better pavement than the stone which is produced in that vicinity; and such a note is incorporated in practically all of the plans for that district.

The district engineer for that district, Charles R. Waters, states that they require the gravel used to be strictly high class. The specifications require a percentage of wear not greater than 12. This eliminates gravel containing slate or other soft stone. The gravel and sand are required to be clean. Like other users of concrete, the department is becoming more rigid and more exacting in requirements. Consideration is being given to the

bulking of damp sand, and it is expected that the state will soon be testing gravel or stone for soundness as well as abrasion. It now measures the coarse aggregate by volume, but it probably will soon follow the example of some other states and weigh it. It is possible also that the inundation process for sand will come into use in the state.

Two illustrations of two-course jobs are offered by work at present under construction, one on the Lake Shore road south of Lackawanna just outside of the Buffalo city line, in which the bottom course is slag; and on the new Millersport road, just west of Main street, which is of gravel throughout. The construction of the two-course roads consists of laying a bottom course of the regular mix, and placing on top of it a layer of concrete of a richer mixture using a smaller size aggregate. The usual practice is to lay six or seven inches of base using number 1, 2 and 3 size aggregate with a 1-2-3½ or 1-2-4 mix; and on this a top of pea gravel two inches deep with a mixture of 1-1½-2. The cement factor runs about 1.6 for the base and 2.2 for the top. Owing to the greater quantity of material in the base, the total quantity of cement used is not much greater than the amount used in the ordinary one-course pavement. The specifications permit the base to be made of stone, gravel or slag.

Successful and economical construction of a two-course pavement lies in organizing the transportation of the aggregate. It is necessary to bring up several bottom course batches to every one for the top course. In reality, two-course pavements have been built in the state for years on every job where the base has been screeded to place the reinforcement. The only important extra equipment needed is a second measuring hopper. Batches for both courses are put through the same mixer, the only difference in addition to the size of gravel and proportion of mix being that the operator has to change the gauge on the water tank when he changes from bottom to top course.

Mr. Waters states that they expect to obtain from this type of pavement a denser, more impervious surface of smoother riding qualities and greater durability.

The traffic on many roads in this district is exceedingly heavy and many of the paved roadways are 30 and 40 feet wide, providing for three and four lanes of traffic. The district has just finished a 40 foot pavement from Niagara Falls to Lewiston Heights, and the Millersport river road and other routes close to Buffalo are built in four ten-foot lanes. The Lake Shore road has a peak traffic of more than 25,000 vehicles per day.

Sand On Gumbo Roads

Road users and road engineers in Kansas and neighboring states are familiar with the material known as gumbo. In speaking of this material as found in Marion county, Kansas, C. M. Hartsock, county engineer, states that "it is difficult to maintain in wet weather and equally difficult to drive over at such times." Many who have experienced it would be apt to say "impossible" rather than "difficult." In 1927 the Board of Commissioners of Marion county decided to try sand surfacing on the gumbo roads, most of which did not carry enough traffic to warrant an expensive paving program. One of the most important highways was chosen and a stretch of 1¼ miles just west of Marion was treated with sand. This proved so successful that the sanding was extended to Hillsboro, 8.7 miles away. Since then an additional 18 miles has been treated in this way.

The sand for surfacing is imported from the Arkansas river, two counties away, pit sand having a gradation factor between 3.00 and 3.75 being found satisfactory. The county furnishes the material and contracts for hauling to the roads and placing in windrows along one shoulder. An average of 600 cubic yards is spread per mile, the amount being varied according to the nature of the soil encountered. The spreading is done by the regular patrolmen. A one-man outfit consisting of a two-ton crawler pulling a patrol machine is used to spread the sand and maintain the finished road. The cost of such a road averages about $1,544 per mile.

During the first half of 1928 a patrol unit travelled 1829 miles in 385 working hours, maintaining sand roads which totalled, toward the end of the period, more than 25 miles in length. The operating expenses were $94.32 for gasoline, $15.60 for oil and $250.25 for patrolman's salary; a total of $360.17. This is equivalent to 19.7c. per operating mile, or probably less than $20.00 a mile for the half-year of maintenance.

Abrasion Tests for Stone and Gravel

Tests by U. S. Bureau of Public Roads lead to suggestions of changes in specifications for road gravel

Most state highway departments in their specifications permit the use of either crushed stone or gravel as aggregate for concrete, most frequently giving the percentage of wear as determined by the Deval abrasion test as the quality requirement. It is frequently stated that a stone with a percentage of wear of 5 is of the same quality as a gravel with a percentage of wear of 15, but very few data are available for establishing this relation.

The Division of Tests of the United States Bureau of Public Roads has carried on a series of tests for obtaining information on this point. A sample rock was tested by the standard method and then the standard gravel abrasion test was made on rounded particles prepared by the Deval machine from the same rock sample. Several such tests were made in 1926 on rock received as routine samples. In 1927 a brick rattler was used to round off rock particles to gravel shape. Samples of stone were taken as supplied by a stone crusher, and also ledge rock from the material being sent to the crusher was obtained and broken by hand. Abrasion tests were then made using cubical pieces broken by hand from ledge rock, others using crushed rock from the crusher, and finally the standard method for gravel using particles of rock artificially rounded into gravel shape; the last having

been obtained by placing 100 to 150 pounds of graded crushed rock in the brick rattler with an abrasive charge of 200 pounds of ½-inch and 1-inch steel cubes, letting the machine run until inspection showed that the crushed rock had worn into the semblance of gravel.

On comparing the results, a very unexpected relation was presented. While the ordinary assumption was that the ratio between the percentages of wear in abrasion tests of rock and gravel is as 1 to 3, the ratio found by these tests was as 1 to .86. In other words, with the materials used, the loss in the gravel abrasion tests is only 86% of that in the rock tests. All of the test results with one exception showed this general relation. As an explanation of this, the investigators state that the average natural gravel, especially that of glacial origin, is not of uniform composition. This nonuniformity in the average gravel emphasizes a fundamental weakness in the gravel abrasion test, and raises a question as to the suitability of such a test. Two samples with the same percentage of wear may vary widely in their suitability for use as a concrete aggregate. A gravel of reasonably uniform quality is more acceptable as an aggregate than another gravel composed of fragments which individually show a wide range in resistance to wear, but with the same or even a higher average loss in the abrasion tests. The abrasion test as now made does not differentiate between samples of uniform and nonuniform quality, and it is suggested by D. O. Woolf, assistant materials engineer of the Division of Tests, who reported this investigation, that "the test should either be modified to determine the uniformity of the material, or be supplanted by other tests which do determine this quality."

Certain static-load and impact tests to determine the percentage of soft or disintergrated particles in a gravel are now being investigated. These include a static-load test developed by the Iowa State Highway Commission, which, as well as the impact test, is described in the United States Department of Agriculture Bulletin No. 1216, "Revised Tentative and Standard Methods of Sampling and Testing Highway Materials," which is about to be published. "The percentage of extremely soft or disintegrated fragments, rather than the percentage of wear on the entire sample, may prove to be the essential feature in the selection of gravel for use in concrete."

Mixing Time for Pavement Concrete

An extensive investigation has been conducted by the Bureau of Public Roads to determine the effect of the length of the mixing period on the quality of the concrete mixed in standard pavers. In summing up the investigation and the conclusions therefrom, the report of the Bureau states that "The evidence strongly indicates that where standard 21-E and 27-E pavers which are in good condition are used, neither strength nor uniformity of test results is improved by mixing the concrete over 45 seconds.

"As ¾-minute mixing provides an insufficient factor of safety for practical operations, and as it is doubtful whether construction processes other than the mixing operation itself can be speeded up sufficiently to take advantage of the marginal time fraction, it is recommended that a mixing time of one minute be adopted as the minimum consistent with assurance of reasonable uniformity and adequate strength of the concrete. The evidence is strong that thoroughly satisfactory concrete can be produced by pavers in good condition with a one minute mixing period."

The tests quite generally disclosed no appreciable difference in strength between concrete mixed for ¾ of a minute and longer periods up to three minutes, but half-minute mixing failed to produce satisfactory concrete. It is apparent, therefore, that reduction of the mixing time to ¾ of a minute would leave a very narrow margin of safety to allow for the normal irregularities of practical operation. It may also be questioned whether the pace set by so short a mixing time can be regularly and consistently maintained by the hauling equipment and other units of the construction plant. Weighing the results of the tests against these considerations, the engineers recommended the adoption of a mixing time of one minute as the minimum time desirable for practical operation.

Nebraska Sand-Gravel Roads

By C. N. Conner

Note: The following is a summary of an investigation taken from test analyses and field data for samples obtained from 76 Nebraska road projects. The investigation was conducted by the Department of Public Works, State of Nebraska. The report and the investigation were completed March, 1928, by C. M. Duff, testing engineer.

Gravel roads comprise a greater mileage of our surfaced highway system than any other type, in fact, the percentage of gravel roads exceeds that of all other types combined. Interest in gravel roads is practically universal. This report shows clearly the successful use of local sand-gravel as a surfacing material in Nebraska.

HISTORY OF NEBRASKA SAND-GRAVEL ROADS

During the past four years Nebraska has constructed 3,246 miles of sand-gravel roads, varying in thickness from ½ inch to 4 inches. Prior to 1924 the total mileage of sand-gravel roads in Nebraska was only 153, but this small amount was sufficient to show the adequacy of this type of Low-Cost Improved Road. The following summary will show the rapid growth of sand-gravel roads in Nebraska and the thickness of the application used.

Year	*Miles*	*Year*	*Miles*
1919	42	1923	11
1920	15	1924	462
1921	32	1925	908
1922	53	1926	693
		1927	1451*

*Includes 268 miles which have been given a second application.

Thickness	*Miles*	*Thickness*	*Miles*
½ inch	7	2 inches	1121
¾ inch	53	3 inches	1897
1 inch	224	4 inches	263
1½ inches	98	6 inches	4

It can clearly be seen from the above tabulation that sand-gravel roads in Nebraska are no longer an experiment. This type of Low-Cost Improved Road is being referred to in this investigation as a sand-gravel road because it is distinctly different from the class of roads usually referred to as gravel roads or from the class referred to as sand-clay roads. From the standpoint of materials of construction it lies between these two classes and is superior to both. It partakes of the smoothness of a sand-clay road and has the wearing and carrying capacity of the best gravel roads.

The general specified analysis of the material to be used for surfacing is as follows: 100% passing one inch sieve, from 0 to 50% retained on a No. 4 sieve, and from 70 to 90% retained on a No. 10 sieve. This material is fine enough so that the surface does not ravel and with proper maintenance can be kept in excellent condition.

This type of road is entirely free from slipperiness and can safely be traveled at higher speeds than most pavements and with more comfort. The only objectionable feature of this type of road is the dust nuisance, which it is hoped may later be partially overcome by the use of the proper road oil. The low cost of construction and maintenance of sand-gravel roads in Nebraska is largely responsible for their rapid growth. A road consisting of a three-inch application of sand-gravel and of a width 3 feet less than the clear roadway can be constructed and maintained, and replaced every two or three years, for a price equal to only the interest, figured at 5%, on the amount that would be required to construct a pavement.

Nebraska, by adopting the present sand-gravel road program, has been able to expand its mileage of improved roads from 10 to 20 times the amount that would have been possible under a paving program. It is generally considered that gravel roads are not economical in other states where the traffic exceeds 500 vehicles per day, but this type of Low-Cost Improved Road constructed with a four-inch application of sand-gravel in Nebraska has proven successful where traffic has been as high as 2,500 vehicles daily.

The greater part of the sand-gravel roads of Nebraska have been constructed on the natural surface soil, which after being shaped to the proper cross-section and grade is considered the subsoil of the road surface. However, part of the roads, located largely in the north central section, have been constructed over very sandy soil, and before surfacing these with sand-gravel it was first necessary to clay surface the natural soil.

DISCUSSION OF MATERIALS USED IN NEBRASKA SAND-GRAVEL ROADS

Nebraska is particularly fortunate in having an abundant supply of sand-gravel which is well distributed over the state. There are two distinct sources of supply, the one is a sedimentary deposit laid down by stream flow, and the other is a glacial deposit. The sedimentary deposit is composed chiefly of very hard and durable grains of quartz and feldspar and is generally more durable than the glacial deposit, which is also made up largely of quartz and feldspar but contains some limestone, sandstone, and disintegrated granite which do not show as high a resistance to wear.

Almost all commercial sand-gravel is obtained from the sedimentary deposit, which is usually located adjacent to rivers or where there was formerly a river bed. The material lies in strata which vary from a few feet to over sixty feet in depth. Most of the commercial plants are located where the underflow is sufficient to operate them by pumping. As the sand-gravel is removed, lakes are formed. Some of these plants pump the material out to a depth of over fifty feet. Sand-gravel obtained by this means is very clean and contains practically no silt and clay.

Most of the local sand-gravel, which is an unwashed product, is obtained from pits which are located in glacial deposits. The sand-gravel from these pits usually contains considerable silt and clay and excess fine material, which is partially removed

SUMMARY OF DATA COLLECTED

Content Found in Sand-Gravel Mats

	In all 76 projects	In the 55 projects constructed with commercial sand-gravel	In the 21 projects constructed with local sand-gravel
Less than 5% clay	4%	4%	5%
From 5 to 10% clay	24%	23%	24%
From 10 to 15% clay	43%	34%	66%
From 15 to 20% clay	25%	33%	5%
More than 20% clay	4%	6%	None
Less than 15% silt and clay	9%	9%	9%
From 15 to 20% silt and clay	19%	16%	24%
From 20 to 25% silt and clay	29%	24%	43%
From 25 to 30% silt and clay	22%	22%	24%
From 30 to 35% silt and clay	7%	9%	None
From 35 to 40% silt and clay	9%	13%	None
More than 40% silt and clay	5%	7%	None

Maximum range of clay content, including all projects, 3.6% to 35.9%.

Maximum silt and clay content in projects using local sand-gravel, 28.2%.

Grading of the Sand-Gravel Obtained from the Entire Mat

Showing the percent of projects that had a given grading.

Considering all 76 Projects

Amount retained on sieve	Size of Sieve No. 3	No. 4	No. 10	No. 20	No. 30
Less than 5%	24%	1%			
5 to 10%	37%	19%			
10 to 20%	34%	50%	3%		
20 to 30%	4%	25%	4%		
30 to 40%		4%	19%	1%	
40 to 50%	1%	1%	23%	5%	2%
50 to 60%			29%	13%	3%
60 to 70%			17%	24%	13%
70 to 80%			5%	28%	24%
80 to 90%				28%	42%
90 to 100%				1%	16%
Considering the 55 Projects Constructed with Commercial Sand-Gravel.					
Less than 5%	15%				
5 to 10%	45%	9%			
10 to 20%	36%	58%			
20 to 30%	4%	29%	2%		
30 to 40%		4%	13%		
40 to 50%			24%	2%	2%
50 to 60%			35%	12%	4%
60 to 70%			19%	20%	9%
70 to 80%			7%	29%	20%
80 to 90%				35%	45%
90 to 100%				2%	20%
Considering the 21 Projects Constructed with Local Sand-Gravel.					
Less than 5%	48%	5%			
5 to 10%	14%	42%			
10 to 20%	28%	28%	9%		
20 to 30%	5%	15%	10%		
30 to 40%		5%	33%	5%	
40 to 50%	5%	5%	24%	14%	5%
50 to 60%			14%	15%	
60 to 70%			10%	33%	24%
70 to 80%				24%	33%
80 to 90%				9%	33%
90 to 100%					5%

Comparison of Average Gradings of Sand-Gravel Obtained from Washed Sample of Entire Mat.

Average % of Sand-Gravel retained on sieves.

Sieve No.	All 76 Mats	55 Commercial Mats	21 Local Mats
3	9.2	9.4	8.9
4	17.1	17.9	14.9
10	49.1	52.4	40.2
20	71.2	74.1	63.6
30	79.4	81.2	74.7

by screening. The local deposits are used only on projects where truck haul is economical.

There are two ways in which a deposit carrying an insufficient amount of material retained on the No. 10 sieve may be used. If the pit contains oversize material, this may be crushed to a size less than one inch in diameter and be used with the excess finer material to produce a grading which meets the specifications. The other way in which a pit containing too much fine material may be used is to place more material on the road than specified. The amount of additional material required must be sufficient to bring the total amount retained on a No. 10 sieve up to the amount specified on the basis of the original thickness required by contract. The per cent of additional material to be added may be determined from the mechanical analysis of the sand-gravel by dividing the deficiency on the No. 10 sieve by the amount retained on the No. 10 sieve and multiplying by 100. The deficiency may also be made up by adding a sufficient amount of coarser sand-gravel to bring the amount retained on No. 10 sieve up to the specified amount based on the original thickness.

The subgrade material upon which the sand-gravel road is constructed also plays a very important part in the life and maintenance of the road. One of the first requirements for obtaining a satisfactory surface is the proper construction and drainage of the subgrade. Where the sand-gravel surface is constructed from commercial pumped sand-gravel, the binder for the surface must come almost entirely from the sub-soil material.

The small amount of binder is also obtained from the gradual disintegration of the sand-gravel due to wear from traffic and maintenance. The importance of this abraded material as a binder has not been fully determined but it no doubt depends largely on the quality of the subsoil material with which it becomes incorporated.

Where the sand-gravel surface is constructed from material obtained from local bank pits it usually contains some silt and clay, which in some cases is an excellent binder while in other cases its value is questionable.

GENERAL CONCLUSIONS

Briefly summarizing a few of the outstanding results of the investigation, it was found that:

The sand-gravel in bottom half of mat was consistently coarser than in the top half.

The clay content was usually higher in the bottom half of mat than in top half; and the same was true of the silt and clay content.

In general, a distinct line of demarcation exists between the sand-gravel mat and the subsoil.

Practically all of the sand-gravel found in the mats was finer than specified at the time of construction.

The grading of local sand-gravel was much finer than for commercial sand-gravel.

The presence of a limited amount of silt and clay in sand-gravel is not objectionable.

The average clay content of all the sand-gravel mats is 12.8%; of those constructed from commercial gravel, 13.5%; and of those constructed from local gravel, 11.2%.

The average silt and clay content of the sand-gravel mats is 25.0%; of those constructed from commercial gravel, 26.4%; and of those constructed from local gravel, 21.3%.

The presence of clay, or silt and clay, in sand-gravel before being placed on the road has little or no effect on the clay or the silt and clay content after compaction in road.

Commercial sand-gravel composed chiefly of quartz and feldspar shows a higher resistance to abrasion than local sand-gravel which usually contains some limestone and soft sand-stone pebbles.

Sand-gravel which has a uniform grading produces a smoother road surface and is more easily maintained.

Sand-gravel having a maximum size of ⅜ inch with 40% or more of the material retained on a No. 10 sieve will make a satisfactory sand-gravel road, but it will probably not have as long a life as would be obtained from the use of standard sand-gravel having a maximum size of 1 inch with 70% or more of the material retained on a No. 10 sieve.

Subsoil is an important factor in the maintenance of sand-gravel roads. The information so far obtained indicates that the ability to maintain the road surface free from corrugations will depend largely upon the quality of sub-soil.

Proper drainage is very necessary to prevent rutting and disintegration during wet weather.

Hornell Sewage Treatment Plant

Actual construction work on a sewage treatment plant for the city of Hornell, N. Y., was begun a few weeks ago. The plant, for which the taxpayers have voted $180,000, will consist of Imhoff tanks and glass covered sludge drying beds. An intercepting sewer will also be constructed, which will eliminate the discharge of sewage into the river within the city limits. This action by the city was taken as a result of investigations by the New York State Department of Health upon the pollution of the Canisteo river, complaints against which had been made by residents of communities along the river below Hornell.

Typhoid in Baltimore From Oysters

The Baltimore City Health Department in January, 1927, learned that two cases of typhoid fever in that city were of persons who had attended an oyster roast given by a local trade union; and about the same time the Baltimore county health officer reported four cases which had attended the same function. This led to a detailed investigation by the city health department and the Department of Epidemiology of Johns Hopkins University, aided by the U. S. Public Health Service, the Maryland State Department of Health and the Virginia State Department of Agriculture.

The oyster used at the "roast" (where some oysters, at least, were eaten raw), were obtained from a packer at S——, Va., and it was learned that oysters from the same source were served at a lodge supper, following which 5 of the 150 present developed typhoid fever. It was found that there had been several cases of typhoid in and near S—— in 1926, one of them a tonger for the packer who furnished the oysters for these suppers; and

that the oyster plantings might be contaminated from the privy of the packing house by unusually high tides.

The report of the investigation was published in September, 1928, by the Public Health Service, and contained the following conclusion:

"From the facts presented, it is concluded that shell oysters from S., Va., contaminated from local sources, were directly responsible for 15 cases of typhoid fever and at least 12 cases of gastroenteritis occurring among those who partook of a supper given October 24 and an oyster roast given November 14, 1926, in Baltimore. Suspicion also attaches to oysters from this source as being possibly responsible for some or all of 8 additional cases in residents of Baltimore; but as to these cases, the evidence, though highly suggestive, is not conclusive."

Sewage Pumping in Florida

Along both the Atlantic and Gulf coasts of Florida, the land is flat and comparatively low and the ground water correspondingly high, which conditions present problems in designing sewerage systems for cities in those localities. The result most immediately evident is the necesity for pumping if the sewage has to be carried any considerable distance to an outlet. Fortunately, few of the buildings in Florida have cellars or basements, and thus the sewer does not need to be laid at any considerable depth either to receive the sewage, or of course to avoid the effect of freezing. However, since the ground has practically no slope and the sewer must have a sufficient slope to give self-cleansing velocities, the depth of the sewer in a comparatively short distance reaches the point where it is below ground water level and where the cost of excavating the trench becomes so considerable that it is cheaper, as well as giving more reliably efficient service, to pump the sewage to a higher level and start the sewer line near the ground surface again. This requires a number of pumping plants distributed throughout any large city.

An illustration of this is Miami. The plans of the sewerage system for this city provide for about 25 lift stations. Most of these are placed underground, both to avoid the necessity of purchasing land of high value and also to conceal the presence of the station. The first four stations installed were of steel tanks designed especially for this purpose by Fairbanks, Morse & Co., and provided with that company's trash pumps. One of these was located under street railway tracks and the other three in thickly congested traffic ways. Later it was decided to provide more space in the lift stations in order to equip them with special control equipment and water level recorders, and underground concrete stations were designed. Two of these have recently been completed and five more will soon be in operation.

These stations are maintained by a crew of three men, a mechanic and two laborers. Each station is visited daily and the chart removed from the water level recorder and the pumps and motors checked for oil and operation. This crew makes all minor repairs and adjustments to the equipment. Duplicate parts on hand provide spare parts for pieces requiring major repairs. The cost of operating these stations ranges from the stand-by charge to several hundred dollars per month, depending upon the condition of the sewer and the area served.

When the underground stations were flooded at the time of the 1926 hurricane, they were out of service for several days after the storm until electric current could be made available. The first work of the power company after the storm was to rebuild power lines to the water supply stations, and the second to provide lines to the sewage pumping stations. As soon as current was available, which was six days for the last station to go into action, the pumps were ready to return into continuous service.

Harrison County, Mississippi, Sea Wall

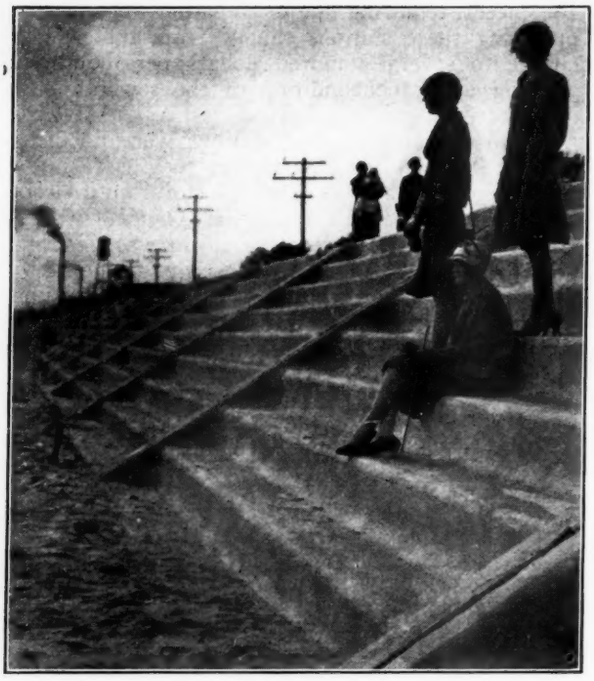
Twenty-four miles long, built to protect a roadway along the beach from destruction by the waves

Harrison county, Mississippi, has built what is said to be the longest concrete sea wall in the world, and it was dedicated with elaborate ceremonies this spring. This wall is 24 miles long and cost about three and a half million dollars.

The Mississippi Gulf Coast, and particularly that lying in Harrison county, has been subject for years to periodic encroachment of tidal waters, but not until a few years ago had property values become sufficient to warrant the enormous cost of adequate protection. In 1915 a storm washed away more than 50% of the beach roadway running from the west end of Pass Christian to the east end of Biloxi. This brought matters to a head and the state legislature of that year passed a law to provide for constructing a protecting sea wall, but part of the law was found unconstitutional.

The World War postponed any further efforts until in 1923 the economic conditions of the entire South had become such that the people of the Mississippi Gulf coast felt that they could now undertake this long desired work. In 1924 a law was enacted by the legislature authorizing the Governor of the state to appoint a commission to construct a sea wall and the county was authorized to issue bonds in sufficient amount to meet the cost, to be liquidated from the income of the county's share of the state gasoline and motor license tax, since the purpose of the wall was largely the protection of the driveway along the Gulf. The Road Protection Commission (commonly known as the Sea Wall Commission) was promptly appointed and engaged H. D. Shaw, city engineer of Gulfport, as its designing and supervising engineer, later engaging Col. A. M. Shaw as consulting engineer.

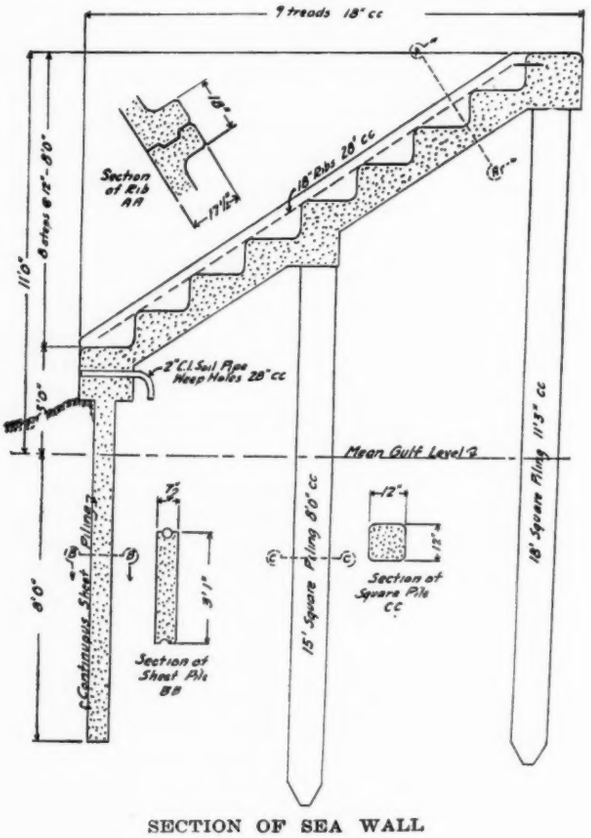
After studying the various designs and types of sea walls, Mr. Shaw decided to adopt the step type wall, having the general features of what is known as the De Muralt system, designed by a Dutch engineer, although the details of the wall as finally worked out are quite different from those used by



PART OF THE MISSISSIPPI GULF COAST SEA WALL

Mr. De Muralt in a wall built in Holland in 1905. One of the arguments in favor of this wall was its appearance, which was thought to add to rather than detract from the beauty of the coast line.

The construction of the wall was divided into two contracts, each providing for walls of both 11-foot height and 8-foot height; about three-fourths of it being 11 feet high and one fourth 8 feet above mean Gulf level. Under the first contract the cost of the 11-foot wall was $29.17 per lineal foot and for the 8-foot wall $23.78. Under the second contract the costs were $28.02 and $23.37 respectively; these costs including all administrative and engineering items.



SECTION OF SEA WALL

There were involved in the construction of this wall 121,200 cubic yards of concrete, requiring 185,000 barrells of cement, 63,500 cubic yards of sand, and 98,000 cubic yards of gravel. The reinforcement consisted of 5,510 tons of rods and 1,330 tons of expanded metal. The drainage system required the laying of 41,900 lineal feet of pipe and the structure was supported by 41,697 tons of treated piles, and 29,261 square piles.

In deciding upon the slope to be given to the wall, Mr. Shaw made sections of the design on cross-section paper using various slopes, the areas of the several sections being designed to insure the same slab strength. It was found that the slope of 1½ to 1 gave the required strength with a minimum amount of concrete. This slope also is slightly less than the angle of repose of the soil fill and thereby gives the full bearing power of the soil with just enough earth pressure to equalize the weight of the structure.

Piles were placed under the structure, not primarily as supporting members, but they were considered principally as anchors to the structure; but they will render support to hold the structure in place in case of local washouts. (Incidentally, the correctness of this assumption has already been proven by an actual demonstration). In estimating the strength of the structure, the only definite data as to impact of waves available were a series of observations by the late Col. Gailliard of the U. S. Army, from which it appears that the maximum wave force on the east coast of Florida produced an impact of 633 pounds per square foot. It was assumed that on the Mississippi Gulf Coast, which is more or less protected by a chain of islands, the force would be considerably less than that, and therefore the designer arbitrarily selected a figure between 650 and 680 pounds per square foot as greater than any impact to which the structure would be subject; which was further augmented by the usual factors of safety; and as the slab was designed independent of the supporting fill, this furnishes an additional factor of safety.

The vertical joints were spaced 28 feet apart because the expanded metal used for reinforcement comes in standard widths of 7 feet; and to make the panels longer would have necessitated a steel form work which would have been more or less unweildy.

The land behind the sea wall had to be raised several feet to bring it level with the top of the wall and the material required for this was provided by suction dredges obtaining the material in the bay. These were required to operate beyond a distance of 1000 feet from the shore line in order to prevent the formation of holes which would be dangerous to children and other wading along the shore; which distance also serves as a safeguide against undermining of the wall because of such holes. It is probable that these will fill up in a few years by the natural action of waves and storms.

Recent Legal Decisions

PITTSBURGH ZONING ORDINANCE HELD APPLICABLE TO ELECTRIC SIGNS

The Pennsylvania Supreme Court, in Appeal of Liggett, 291 Pa. 109, 139 Atl. 619, holds that the Pittsburgh Zoning Ordinance of August 9, 1923, dividing the city into use districts and excluding from residence districts advertising signs and billboards is within the powers conferred on cities of the second class by Pa. Act June 21, 1919, to regulate and restrict the location of trades and industries by zoning ordinances, and to designate the trades and industries which shall be excluded from any specific district or subjected to special regulation. The erection and maintenance of an electric signboard was held to be part of "the industry or trade of public advertising" in which a signboard company is engaged, and such a business, requiring the maintenance of a large plant, was held a trade or industry within the meaning of the act.

CONTRACT TO BE CONSIDERED IN CONSTRUING PUBLIC WORKS CONTRACTOR'S BOND

Where suit is filed on a contractor's bond, in this case to secure faithful performance of a contract for the construction of a lighting system for the town, the contract and bond may be considered together to ascertain the intent of the parties; and separate paragraphs or isolated clauses therein cannot be construed as controlling, when violative of the intent of the written contract, considered in its entirety.—Commercial Casualty Ins. Co. v. Town of Breckenridge, Oklahoma Supreme Court, 262 Pac. 208.

ASSIGNMENT OF MATERIALMEN'S CLAIMS AS AFFECTED BY STATUTORY BOND

The California Supreme Court holds, Continental Nat. Bank v. Republic Casualty Co., 262 Pac. 300, that the bond of a contractor for school buildings, in proportion to the amount of the contract, as required by California Public Works Act and given and accepted at the time and in the manner required by the statute, is a "statutory bond," under which no recovery could be had for certain assigned claims of materialmen and laborers which had not been perfected prior to the assignment.

SWIMMING POOL IN PUBLIC PARK HELD NOT AN "ATTRACTIVE NUISANCE"

The Kansas Supreme Court holds, Gilliland v. City of Topeka, 262 Pac. 493, an action for damages for the death of a six-year old child drowned in the swimming pool in a public park in the defendant city, that a swimming pool in a public park of a city, constructed of concrete and equipped with the usual swimming-pool accessories, is not a nuisance, although attractive to children, and cannot be classed as an "attractive nuisance" within the rule of the turntable cases, as that rule is applied by the Kansas Supreme Court.

"MAINTAIN" HELD NOT TO COVER REMOVAL OF ELECTRIC TRANSMISSION LINE

The city of Mullinville, Kan., constructed a transmission line from Bucklin to supply Mullinville with electric light, heat and power, and constructed a distribution system within the city. The entire plant was leased to a service company for operation, and the service company agreed to maintain the transmission line. The line was constructed on a public highway. The board of county commissioners, desiring to improve the highway, ordered the line removed, and widened the highway. Pursuant to the order, the line was removed, and was rebuilt on the addition to the highway made by widening it. In an action by the service company against the city, it was held, Electric Service Co. v. City of Mullinville, 262 Pac. 536, that the expense of removing and rebuilding the line should be borne by the city; that it did not fall within the ordinary meaning of the word "maintain,"—to keep in a particular state or condition; and that the nature of the contract clearly indicated that good operating condition, such as would furnish a good and sufficient lighting condition, was the specific character of maintenance contemplated. "Demolition of the line and reconstruction at another location is something quite different from keeping it up to a standard of efficiency, and it is scarcely reasonable to extend the meaning of the word 'maintain' to include such a remote and extraordinary contingency as that occasioned by the removal order."

RIGHT TO LIGHT AND WATER NOT DEPENDENT ON BUILDING SEPTIC TANK AS ORDERED BY HEALTH DEPARTMENT

A public utility cut off a customer's water and light because he constructed a cesspool on his property instead of building a septic tank to care for his sewage, as ordered by the state health department. The customer sued for damages. The Michigan Supreme Court, Ten Broek v. Miller, 240 Mich. 667, 216 N. W. 385, affirming decree in his favor, says: "The installing of a septic tank was purely a collateral matter, and had no relation to the duty of defendant company to furnish the light and water and receive its pay therefor. If plaintiff were violating a rule of the state health department, he could be proceeded against for its infraction in the proper forum. This would be a more orderly way of disposing of the dispute than for defendant to substitute itself for a court and punish plaintiff by shutting off his water and light."

Even if the defendant had a rule requiring septic tanks to be installed, and it was not complied with by plaintiff, it is held that would be no adequate reason for refusing to supply him with water and light.

Defendant was a resort company, and incidentally employed in serving the public with water and light. "This was a public service, and it was its duty to serve all patrons alike, and not to discriminate against any one of them, and this rule would apply, even though defendant were only a semipublic utility corporation. It had a right to provide reasonable rules and regulations in the conduct of its business of furnishing water and electric light, and, unless these rules and regulations were complied with, it would have a right to decline service. It was, however, the duty of the resort company to furnish water and light under reasonable rules and regulations.

There is no claim that plaintiff refused to pay the rate charged for water and light, nor is there any claim that he did not pay in accordance with the rules. . . ."

REPAIRS ON TRUCKS USED IN HIGHWAY CONSTRUCTION HELD COVERED BY CONTRACTOR'S BOND

A claim on a road contractor's statutory bond for a garage account embraced labor performed on the contractor's trucks, an engine and a number of tires. The Circuit Court of Appeals, Fourth Circuit, holds, Maryland Casualty Co. v. Ohio River Gravel Co., 20 Fed. (2d) 514, that, while one who supplies a tire or a motor for a truck is no more entitled to recover under such a bond than one who furnishes the truck itself, such things coming either under the head of equipment or repairs which add materially to the value of equipment, still, there are repairs of an incidental and inexpensive character, such as most of those embraced in this account seem to have been, which do not in any true sense add to the value of the equipment, but are incidental to the carrying on of the work and represent merely ordinary wear and tear or its equivalent. The labor of a mechanic who keeps in repair and running condition a fleet of trucks used on the job adds to and becomes a part of the finished structure; and it makes no difference whether the mechanic does the work at the scene of the operation or in his own garage. Those items of the account which represented mere incidental repairs upon the trucks used on the job necessary to keep them in running condition for performance of the work, it was held, have been allowed as being within the protection of the bond.

INJURY FROM BARBED WIRE FENCE ERECTED BY INDIVIDUAL IN PRIVATE STREET

The New York Appellate Division holds, Brothers v. Village of Ilion, 229 N. Y. Supp. 44, in an action for injuries by coming in contact with a barbed wire fence wrongfully erected in a public street by one defendant and negligently allowed to remain there by the municipality, the other defendant, that a verdict exonerating the individual defendant but condemning the village for failure to remove the fence after notice, must be reversed, as illegal and inconsistent, since no negligence on the part of the village was possible unless there was negligence or wrongful act of individual defendant in erecting the fence.

EXTRA COMPENSATION FOR UNEXPECTED EXCAVATION WORK NOT PROVIDED FOR IN CONTRACT

The contract for the construction of a water conduit for a city provided for unit prices, as follows: For earth, 30 cents per cubic foot; shale, $1.00 per cubic foot; loose rock, $1.00 per cubic foot, and solid rock, $3.50 per cubic foot. When the contract was signed, the parties believed that all the material found in excavating the trench would fall within one of these classifications; and hardpan was not covered by the contract. Hardpan was encountered in the course of the work, and the engineer classed this as earth. The Circuit Court of Appeals, Eighth Circuit, holds, Walbridge-Aldinger Co., v. Rudd, 26 Fed. (2d) 636, that this classification was arbitrary and unfair to the contractor, and that the later was entitled to extra compensation beyond the 30 cents per cubic yard allowed, the amount to be determined by the master who heard the case. It was held immaterial that it was conceded that the engineer acted honestly and in good faith, the testimony and findings of the master and the lower court being to the effect that hardpan was more expensive and difficult to excavate than shale or loose rock, both rated at a dollar per cubic foot, and its presence in large quantities being a surprise to both parties.

ACQUIRING LAKE NEAR CITY HELD A PARK PURPOSE AND WITHIN CITY'S POWER

The Kentucky Court of Appeals holds, Smith v. City of Kuttawa, 1 S. W. (2d) 979, that a city may acquire property beyond its corporate limits for city purposes; and the court quoted In re Mayor, etc., of New York, 99 N. Y. 570, 2 N. E. 642, to the effect that "it is impossible to formulate a perfect definition of what is meant by a city purpose, yet two characteristics it must have. The purpose must be primarily the benefit, use or convenience of the city as distinguished from that of the public outside of it, although they may be incidentally benefited, and the work be of such a character as to show plainly the predominance of that purpose. And then the thing to be done must be within the ordinary range of municipal action. Acquiring and maintaining parks is within that range." It was held that property rights or an easement in a lake deeded to the city, being in the nature of a park purpose, was undoubtedly a legitimate municipal purpose, where it was located so near to the corporate limits that there could be no ulterior motive in its acquisition; and the town, not being expressly denied such capacity, had the capacity to acquire and own the easement and rights.

COST OF REMOVING DIRT AND SPALLS FROM CRUSHED STONE HELD, UNDER CONTRACT, COVERED BY CONTRACTOR'S BOND

Where crushed stone was furnished to contractors for paving and guttering, the contractors agreeing to remove the dirt and spalls in return for a rebate on purchase price, the Arkansas Supreme Court holds, Southern Surety Co., v. Pfeiffer Stone Co., 1 S. W. (2d) 43, that on the contractor's default the cost of removing dirt and spalls by the seller constituted part of the purchase price of stone furnished and used in the construction and was recoverable from the contractor's surety under a bond covering labor and materials furnished and used in the construction.

AUTHORITY TO ISSUE MUNICIPAL BONDS

The Iowa Supreme Court says, Muscatine Lighting Co. v. City of Muscatine, 217 N. W. 468, that it is the settled law of that jurisdiction that authority for the issuance of negotiable bonds by a municipality must be found in express language of statute. Such power cannot be implied. Authority to contract a particular indebtedness, or indebtedness for a particular purpose, is not authority to issue negotiable bonds for that purpose even though after the indebtedness is lawfully contracted it may be refunded by the issuance of bonds.

NEWS OF THE SOCIETIES

Nov. 12-15—ASSOCIATION OF STATE HIGHWAY OFFICIALS. Annual convention at Chicago, Ill. W. C. Markham, Sec'y, National Press Bldg., Washington, D. C.

Dec. 3-7—ASPHALT ASSOCIATION. Seventh annual conference at New Orleans, La. J. E. Pennybacker, Mgr., 441 Lexington Ave., New York City.

Dec. 10-12—NATIONAL HIGHWAY TRAFFIC ASSOCIATION. Annual conference at New York City. Elmer Thompson, Sec'y., 12 E. 53rd St., N. Y.

Dec. 13-14—HIGHWAY RESEARCH BOARD. Annual meeting at Washington, D. C. R. W. Crum, director, Washington, D. C.

Jan. 14-18—AMERICAN ROAD BUILDERS' ASSOCIATION. Annual Convention and Road Show at Cleveland, O. C. M. Upham, Washington, D. C.

Jan. 16-18.—AMERICAN SOCIETY OF CIVIL ENGINEERS. Annual Meeting at New York. Geo. T. Seabury, Sec'y., 33 W. 39th St., N. Y.

Feb. 12-14.—AMERICAN CONCRETE INSTITUTE. Annual Convention at Detroit, Mich. Harvey Whipple, Sec'y., 2970 W. Grand Blvd., Detroit, Mich.

26TH ANNUAL CONVENTION AND ROAD SHOW

The 26th Annual Convention of the American Road Builders' Association and Road Show will be held at Cleveland, O., Jan. 14 to 18. The preliminary program for the meeting has been issued, and is as follows:

Saturday, January 12.—Manufacturers and Distributors Day: 3:30 P. M.—Meeting, Manufacturers' Division, American Road Builders' Association and Distributors.

Monday, January 14.—Exposition Day: 9:00 A. M.—Opening of Exposition, Public Auditorium and Central Armory. The entire day will be given over to visiting the various exhibits.

CITY OFFICIALS' DAY

Tuesday 10 *A. M.*—General Session: Col. R. Keith Compton, presiding. Address of Welcome by Hon. John D. Marshall, Mayor of Cleveland; Response and address by Col. R. Keith Compton, President, American Road Builders' Association; Trend of City Government, Wm. R. Hopkins, City Manager, Cleveland, Ohio; Report of Committee on Administration, Organization and Finance, Chairman, H. C. Whitehurst, Assistant to Engineer Commissioner, Washington, D. C.

Tuesday, 2:30 *P. M.*—Captain H. C. Whitehurst, presiding: Address by Captain H. C. Whitehurst; Report of Committee on Design and Construction, Chairman, Geo. B. Sowers, Deputy Commissioner, Division of Engineering and Construction, Cleveland, Ohio; Report of Subcommittee on Subgrades, Foundations and Bases for Pavements, Chairman, C. A. Hogentogler, Senior Highway Engineer, Bureau of Public Roads, United States Department of Agriculture, Washington, D. C.; Report of Committee on Maintenance, Chairman, Major C. E. Myers, Director of Transit, Philadelphia, Pa.; Report of Committee on Traffic, Chairman, M. O. Eldridge, Assistant Traffic Director, Washington, D. C.

Tuesday, 2:30 *P. M.,* Constructors' Session: S. M. Williams, presiding. Trend of Construction Equipment Design, S. T. Henry; Report of Committee on A Study of Liens in Public Construction, Chairman, A. E. Horst, Secretary and Treasurer, Henry W. Horst Co., Rock Island, Ill.; Prequalification of Bidders on Public Construction Work, Ward P. Christie, Engineer, Associated General Contractors of America, Washington, D. C.

PAN AMERICAN DAY

Wednesday, 10 *A. M.,* Pan American Session: Octavio Dubois, and Thomas H. MacDonald, presiding. Plans and Construction of Central Highway, Cuba, M. A. Coroalles, Construction Engineer, Cuban Department of Public Works, Havana, Cuba; Benefits and Value of the Pan American Division of the American Road Builders' Association, Speaker to be announced: Road Activities in Canada, Speaker to be announced; Success of Mexican National Highway Congress, Frederic A. Reimer, Consulting Engineer, East Orange, N. Y., and a representative of the National Highway Commission of Mexico.

Bornemann, Oct. 17

Wednesday, 2:30 *P. M.*—Engineers' Session: Gibb Gilchrist, presiding. Report of Committee on Depreciation of Equipment, Chairman, W. A. Van Duzer, Assistant Chief Engineer, Pennsylvania Department of Highways, Harrisburg, Pa.; Practical Applications of Recent Highway Investigations, A. T. Goldbeck, Director, Bureau of Engineering, National Crushed Stone Association, Washington, D. C.; Report of Committee on Finance, Chairman, Chas. M. Upham, Secretary-Director, American Road Builders' Association, Washington, D. C.; Report of Committee on Grade Crossings, Chairman, E. W. James, Chief, Division of Design, Bureau of Public Roads, United States Department of Agriculture, Washington, D. C.

Wednesday, 2:30 *P. M.,* Constructors' Session: W. L. Collins, presiding. Recent Changes in Pavement Design and Specifications and How They Affect the Contractor, Speaker to be announced: The Economics of Grading and Paving Operations, Speaker to be announced; Do Construction Costs Justify Present Low Bidding, D. H. Sawyer, Secretary, Associated General Contractors of America, Washington, D. C.

COUNTY HIGHWAY OFFICIALS' DAY

Thursday, 10 *A. M.,* County Highway Officials' Session: Thomas J. Wasser, presiding. Address by Thomas J. Wasser; Report of Committee on Surveys and Planting, Chairman, Stanley Abel, Supervisor, Fourth District, Kern County, Taft, Calif.; Procedure for Making an Economic Survey and Plan for County Highway Development, F. E. Schnepfe, Highway Engineering Bureau, Washington, D. C. (This con-

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sists of a preliminary study of conditions in Prince William County, Va., with a view to making an economic survey and plan for a road program over a period of years; Report of Committee on County Highway Construction, Chairman, Chas. E. Grubb, County Engineer, Newcastle County, Wilmington, Del.; Report of Committee on Rural County Highway Maintenance, Chairman, F. B. Wilkes, Superintendent of Roads, Maury County, Columbia, Tenn.; Report of Committee on Urban County Highway Maintenance. Chairman, Geo. C. Wright, County Superintendent of Highways, Monroe County, Rochester, N. Y.

Thursday, 2:30 P. M., County Highway Officials' Session: Chas. E. Grubb, presiding. Address by Chas. E. Grubb, Report of Committee on County Highway Legislation, Chairman, H. B. Keasbey, County Engineer, Salem County, Salem, N. J.; Report of Committee on County Administration, Chairman, R. B. Preston, Engineer, County Commission of Roads and Bridges, Norfolk County, Portsmouth, Va.; Report of Committee on County Construction and Maintenance Equipment, Chairman, E. L. Gates, Superintendent of Highways, Du Page County, Wheaton, Ill.; Report of Committee on County Highway Finance, Chairman, John J. McHugh, Deputy Clerk, Board of Chosen Freeholders of Hudson County, Jersey City, N. J.

General Information.—The Road Show will be held in the Public Auditorium and Central Armory, opening officially Monday, January 14, at 9 A. M. Owing to greatly increased facilities the Exposition will be larger than last year. There will be over 500 carloads of up-to-the-minute, labor-saving equipment and materials on exhibition.

The convention program will consist largely of committee reports by the leading officials of States, counties, cities and Pan-American countries. These reports will cover every phase of highway work—administration, planning, finance, legislation, construction, maintenance and equipment—and each session will be devoted to a particular Division of the Association, and the subjects presented will be of special interest to that Division. In addition there will be a general session of interest to all road builders, and two sessions devoted to problems affecting contractors.

Reduced railroad fares have been granted by the railroads to all persons attending the 1929 convention and road show. When purchasing ticket, ask for a certificate (not a receipt). This certificate when validated at the Validation Booth at the Public Auditorium, will entitle the purchaser to a return ticket at one-half price.

Hotel reservations should be made immediately through A. J. Kennedy, Vice-Chairman of the Hotel Committee, 1604 Terminal Tower Building, Cleveland, Ohio. Assurance is given by the Hotel Committee that there will be ample accommodations for all, but your cooperation is requested in making reservations as early as possible, in order to avoid any delay or confusion at the last moment.

The Annual Road Builders' Banquet will be held Wednesday evening, January 16, at the Hollenden Hotel, Cleveland. The dinner is $4 a plate, and those desiring to attend should send reservation, together with check, to Chas. M. Upham, Secretary-Director of the Association, 914 National Press Building, Washington, D. C. The check should be made out to the order of James H. MacDonald, Treasurer.

The registration booth will be located in the main entrance lobby of the Public Auditorium. All who attend are requested to register, as it is a convenience when trying to locate anyone for delivery of mail, telegrams and messages, and is also a means of locating friends. There is no charge for registering.

NATIONAL HIGHWAY TRAFFIC ASSOCIATION

The National Highway Traffic Association will hold its annual meeting at the Automobile Club of America in New York City on December 10, 11, and 12; immediately before the meeting in Washington of the National Research Board, scheduled for December 13 and 14, so that those from distant states may attend both meetings on one trip. The directors will meet on Monday morning, December 10 and the five remaining sessions will be given over to technical meetings to hear reports of special studies on such problems as segregating pedestrian and vehicle traffic on different levels, regulation of traffic on through roads, conditions justifying use of rotary traffic, parking regulations, road illumination, synchronous utilization of highway transport and railroad transportation, compulsory motor vehicle insurance, economic basis for taxation of commercial motor vehicles, and kindred topics. The evening periods will be given over to social events. The president, Arthur H. Blanchard, expresses the belief that "this meeting will be outstanding in its suggestions for practical solutions of many serious highway problems, and that some of the results will probably be carried on to successful application through research work sponsored by wealthy leaders."

NATIONAL MEXICAN HIGHWAY CONGRESS AND EXPOSITION

The Second National Mexican Highway Congress and Exposition was held at Mexico City, Oct. 3 to 6. It was attended by more than 60,000 visitors and delegates from twelve countries. The Congress, under the auspices of the Pan American Division of the American Road Builders' Association, was held primarily to give impetus to Mexico's highway building program and to foster a Pan American Highway from Washington to Mexico City.

The first session of the Congress was opened by President-elect Emilio Portes Gil. The exposition was opened by President Plutarco Elias Calles and his Cabinet. President Calles spent two hours inspecting the hundred exhibits brought from the United States demonstrating various phases of highway construction. Both President Calles and President-elect Gil expressed the belief that the construction

of a Pan American Highway would be completed within the next five years.

Approximately 250 engineers and machinery exhibitors, members of the American Road Builders' Association, were in attendance from the United States. President Compton, head of the Association, declared in his address that a Pan American Highway would attract more than a million American tourists annually.

NATIONAL SAFETY COUNCIL

At the annual meeting held at New York, Oct. 3 to 5, the National Safety Council elected officers as follows: President, Henry A. Reninger, Allentown, Pa.; treasurer, G. T. Hellmuth, Chicago, re-elected; managing director, W. H. Cameron, Chicago, re-elected; Vice-Presidents of the National Council: for public relations, Charles E. Hill, New York Central Lines; for local councils, George Opp, New York Central Lines; for public safety, Miller McClintock, Harvard University; for health, Professor C. E. A. Winslow, Yale Medical School; for memberships, A. M. Tode, the Texas Company; for engineering, George Sanford, General Electric Company; for finance, C. E. Pettibone, American Mutual Liability Insurance Company; for education, Albert W. Whitney, National Bureau of Casualty and Surety Underwriters; for industrial safety, E. W. Beck, U. S. Rubber Company.

Directors of National Safety Congress: Ernest P. Goodrich, New York; William E. Metzger, Detroit; William Otter, Chicago; David S. Beyer, Boston; W. R. Boyd, New York; C. L. Close, New York; J. B. Douglas, Philadelphia; F. W. Fisher, Rochester; Isaiah Hale, Topeka; Charles E. Hill, New York; Dana E. Jones, Erie, Pa.; T. H. McKenney, South Chicago; Homer E. Niesz, Chicago; Lew R. Palmer, New York; W. B. Pettibone, Cleveland; G. E. Sanford, Schenectady; David Van Schaack, Hartford, Conn.; J. M. Woltz, Youngstown, Ohio.

Council Representatives on Executive Committee: Edwin Pugsley, New Haven Safety Council; Ancil D. Brown, Safety Division, Syracuse Chamber of Commerce; Frederick E. Schortemeier, Indianapolis Safety Council; Paul Van Cleef, Chicago Safety Council; Clifford Davis, Safety Division, Memphis Chamber of Commerce; Emil Koch, Kansas City Safety Council; Emil J. Niederer, Delaware Safety Council.

TEXAS SANITARIAN'S SHORT SCHOOL

The sixth annual Texas Sanitarian's Short School will be held at San Antonio, Tex., Nov. 7 to 10. The program covers a wide variety of subjects. General sessions will be held on the first day, but milk sanitation will be the theme of the evening session. There will be a symposium on water supply Thursday morning, and on sewage, mosquito control, and general sanitation in the afternoon. There will also be a meeting of the milk sanitation section on this day. Health administration and general sanitation problems will occupy the third day, with the evening session devoted to milk sanitation.

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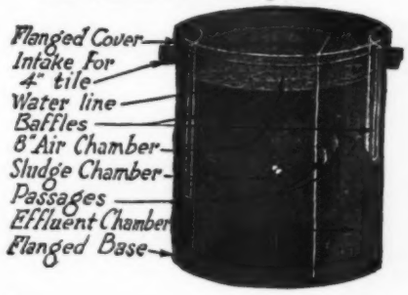

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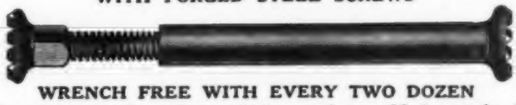

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PERSONALS

F. D. Hawley, for the past 8 years project engineer of the New Mexico Highway Department, has resigned to become a member of the Mountain States Contracting Co.

E. M. De Munn has been appointed superintendent of the Geneseo, N. Y., water works plant.

John R. Peavy, formerly assistant city engineer of Mobile, Ala., has been appointed county highway engineer for Mobile County. He succeeds J. B. Converse.

George A. Cooper of the Monongahela West Penn Public Service Company, Fairmont, West Virginia, has been appointed Assistant Chief Business Specialist in the Division of Simplified Practice of the Bureau of Standards, U. S. Department of Commerce.

BOOK REVIEWS

Elements of Highway Engineering. By A. H. Blanchard and Roger L. Morrison, John Wiley & Sons, Inc., N. Y. Second edition; reset. 350 pages, 158 illustrations, $3.75.

In the thirteen years that have elapsed since this book was brought out, many and important changes in highway engineering have taken place. Consequently this volume represents more nearly a rewriting than a revision. For the most part both illustrations and text have been brought well up to date. The matter is well treated and is clear. Chapter I, which reviews the history of roads and road making is of much interest. It is followed by a chapter on financing and administration; after which the matters of essential data as determined by transport surveys, field surveys and design are considered. Following this the various pavement types are considered in detail.

The Enforcement of Real Estate Liens. By Carl H. Chatters, City Auditor, Flint, Mich. Municipal Administrative Service, N. Y., 52 pp.

Seven of the largest cities in the United States had tax delinquencies greater than 8 per cent for the tax period of 1925. This places a heavy burden upon the paying tax-payer or curtails the activity of the city. Mr. Chatters outlines necessary provisions of a tax sale law. Of interest is the survey of present tax sale methods. In the appendices are given illustrative tax laws and other data of interest and value.

PUBLIC REPORTS

Sewage Polluted Surface Water as a Source of Water Supply. By H. W. Streeter, Sanitary Engineer, U. S. Public Health Service. Reprint No. 1232, Public Health Reports, 5 vols., 26 pp.

A resume of the data available is presented by Mr. Streeter, who has been engaged in research work on this subject for a number of years.

Topographic instructions of the United States Geological Survey. C. H. Birdseye, chief topographic engineer. Bulletin 788. v, 432 pp., 29 pls. (including 2 maps), 18 figs. For sale by the Superintendent of Documents, Government Printing Office, Washington, D. C. Price 60 cents.

A manual intended to replace all former instructions relating to the topographic work of the United States Geological Survey and to serve other organizations engaged in topographic surveying. The attempt has been made to have these instructions complete so far as the technical work of topographic mapping is concerned. The manual has already been published in six separate parts each covering a general phase of the work and each prepared by the member of the Geological Survey best qualified for the task. The technical parts have been reviewed and approved by a committee of the Federal Board of Surveys and Maps. The book contains numerous illustrations that aid in making the instructions clear.

Cannery Waste Treatment Studies. Progress reports on work carried on by Ohio Canners' Association and Association of New York State Canners, Inc., under direction of A. Elliott, Kimberly, Ill., 85 pp.

The results of this work are of great importance to the cannery interests and to those interested in stream pollution control. The studies have shown that a direct oxidation program can be applied effectively to a number of cannery waste products, and that chemical precipitation is adaptable for tomato products waste. The investigations to date have included wastes from peas, kraut, spinach and whole tomatoes.

Sewage Disposal.—Connecticut State Department of Health, Hartford, 36 pages, 14 illustrations.

This bulletin of the Connecticut State Health Department covers a little more ground than is usual in a publication of this kind, and covers it very well. The various types of privies are described and their advantages or defects briefly noted. Considerable space is given to a discussion of small septic tanks. Of especial value are the data regarding subsurface disposal. Sizes and minimum grades of sewers are covered, and basic design data are given for larger plants.

Topographic instructions of the United States Geological Survey: Topographic mapping, by W. M. Beaman, pp. i-vi, 161-378, i-ix (index), pls. 8-28 (including 1 map), figs. 4-12. Bulletin 788-E.

A very complete manual of methods of topographic mapping used by the Geological Survey, containing instructions and explanations for the numerous minute details of the work. The illustrations show many of the instruments used and the principal features of the maps.

STATEMENT OF THE OWNERSHIP, MANAGEMENT, CIRCULATION, etc., required by the Act of Congress of August 24, 1912, of PUBLIC WORKS, published weekly at New York, N. Y., for October 1, 1928.

State of New York, County of New York, ss.: Before me, a Notary Public in and for the State and county aforesaid, personally appeared James T. Morris, who, having been duly sworn according to law, deposes and says that he is the business manager of PUBLIC WORKS, and that the following is, to the best of his knowledge and belief, a true statement of the ownership, management (and if a daily paper, the circulation), etc., of the aforesaid publication for the date shown in the above caption, required by the Act of August 24, 1912, embodied in section 411, Postal Laws and Regulations, printed on the reverse of this form, to wit:

1. That the names and addresses of the publisher, editor, managing editor, and business managers are:
Publisher—Public Works Journal Corp., 243 West 39th Street, New York, N. Y.
Editor—A. Prescott Folwell, Montclair, N. J.
Managing Editor—A. Prescott Folwell, Montclair, N. J.
Business Manager—James T. Morris, White Plains, N. Y.

2. That the owner is: (If owned by a corporation, its name and address must be stated and also immediately thereunder the names and addresses of stockholders owning or holding one per cent or more or total amount of stock. If not owned by a corporation, the names and addresses of the individual owners must be given. If owned by a firm, company, or other unincorporated concern, its name and address, as well as those of each individual member, must be given.)
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5. That the average number of copies of each issue of this publication sold or distributed, through the mails or otherwise, to paid subscribers during the six months preceding the date shown above is (This information is required from daily publications only.)

J. T. MORRIS, Business Manager.

Sworn to and subscribed before me this 19th day of Sept., 1928.
(Seal) R. CROXTON MORRIS,
Notary Public, Westchester County, N. Y.
Cert. filed in N. Y. Co. No. 1143—Reg. No. 9031-A
(Commission expires March 30, 1929)

NEW CATALOGS

Celite Products Co., Los Angeles, Calif. An 8-page pictorial bulletin, No. 340, entitled "Quality Concrete."

Electric Controller Mfg. Co., Cleveland, O. An illustrated 4-page folder describing E C & M control apparatus.

Ingersoll-Rand Co., N. Y. A 4-page illustrated folder in colors describing the I-R 310-foot compressor and other tools

Sullivan Machinery Co., Chicago, Ill. An illustrated folder describing Sullivan air compressors and illustrating their uses.

O. K. Clutch & Machinery Co., Columbia, Pa. A 4-page illustrated folder describing the O. K. portable elevator.

International Cement Corp., N. Y. A 12-page bulletin describing "Incor" high early strength portland cement.

Edson Mfg. Co., Boston, Mass. Circular describing Edson CC suction hose with extra heavy brass couplings.

George Haiss Mfg. Co., N. Y. Booklet 1027, a 16-page catalog describing Haiss snow removal machinery.

Oxweld Acetylene Co., N. Y. A 56-page catalog describing the products of the company.

Zelnicker, St. Louis. A 28-page catalog covering new and used equipment of all sorts for contractors.

Superheater Co., N. Y. A 52-page catalog describing the Elesco Superheater for power plants.

Anderson Engine & Foundry Co., Anderson, Ind. Bulletin No. 35, showing advertising of this company during the past year.

Crouse-Hinds Co., Syracuse, N. Y. Bulletin 2113, describing electric traffic signals. 8 pages; in colors.

Climax Engineering Co., Clinton, Ia. 4-page illustrated folder describing Climax automatic spark control.

O. F. Jordan Co., East Chicago, Ind. 24-page catalog describing Jordan spreaders and ditchers, which are of especial value in railway maintenance work.

Oxweld Acetylene Co., N. Y. A 12-page booklet describing the Carbic low-pressure acetylene generator and a 16-page booklet describing Carbic lights.

Geo. D. Whitcomb Co., Rochelle, Ill. Bulletin 2822 describing 2½, 3½, 4½ and 5-ton gasoline locomotives. 12 pp., illustrated.

International Cement Corporation, N. Y. A 4-page colored folder describing the various uses of "Incor" high early strength Portland cement.

Maine Steel Products Co., South Portland, Me. 4-page illustrated folder describing the complete line of Sargent snow plows, including the New England sidewalk plow.

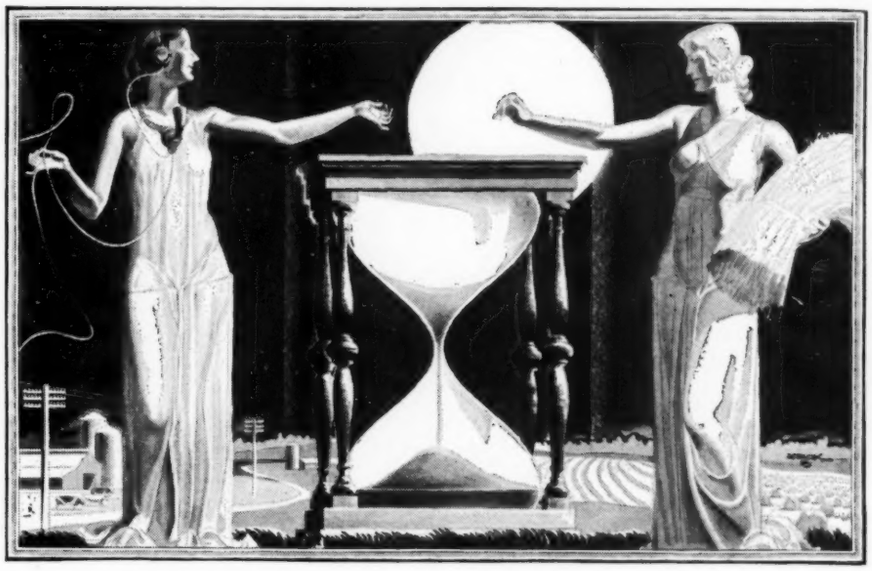
Truscon Steel Co., Youngstown, O. A 48-page catalog describing and illustrating Truscon copper alloy steel doors. Also gives specifications and drafting room standards.

Good Roads Machinery Co., Kennett Square, Pa. An elaborate and valuable 44-page catalog describing in detail the Good Roads Co. rock crushing equipment.

Electric Controller & Mfg. Co., Cleveland, O. A 4-page folder describing EC&M magnets for removing nails, iron, etc., from highways.

Trackson Co., Milwaukee, Wisc., a 4-page illustrated folder describing Trackson loaders and shovels, and an 8-page illustrated folder describing Trackson McCormick-Deering equipment.

Edson Mfg. Corp., Boston, Mass. An illustrated folder describing a line of pumps, including the Type A, patented in 1876, and 1923, and claimed to be the original diaphragm pump, and the Edson rocker arm heavy duty pumps.



Kansas saves Twenty Years

An Advertisement of the American Telephone and Telegraph Company

MORE than three hundred studies are being carried on constantly by the research, engineering and business staffs of the American Telephone and Telegraph Company and the associated companies of the Bell System to accomplish definite improvements in telephone service.

In 1927 the number of local calls not completed on the first attempt was reduced by 5 per cent. This means the better handling of 200,000,000 calls a year.

In 1926 the average time of handling toll and long distance calls was 2 minutes. In 1927 this average was reduced to 1½ minutes, with further improvements in voice transmission.

On 6,820,000 long distance and toll calls made in Kansas in 1927 an average reduction of a minute and a half was made on each call — a total of twenty years saved.

These more than three hundred special studies have as their goal definite improvements in local, toll and long distance service. It is the policy of the Bell System to furnish the best possible service at the least cost to the user.

The American Telephone and Telegraph Company accepts its responsibility for a nation-wide telephone service as a public trust. It is fundamental in the policy of the company that all earnings after regular dividends and a surplus for financial security be used to give more and better service to the public.

New Appliances and Equipment

Describing New Machinery, Apparatus, Materials and Methods and Recent Interesting Installations

Barber-Greene Overload Release

The Barber-Greene Company, Aurora, Illinois, has just perfected an automatic overload release sprocket for its large and small bucket loaders, and coal loaders. This release sprocket, it is claimed, protects completely the machine against all strains on the bucket line. The sprocket has two main elements—the outside race and the inside springs. The chain runs around the sprocket teeth on the outside of the race. The race itself has two raised parts which are in contact with the two rollers of the springs. The spring part is keyed to the shaft. Ordinarily the pressure of the spring rollers against the raised part of the race is sufficient to make the entire sprocket turn together—thus turning the head

BARBER-GREENE RELEASE

shaft and the bucket line. However, when a large boulder or any other big solid object tends to stop the bucket line, the springs compress, allowing the sprocket to run and the head shaft to stand still. Every half revolution thereafter the spring rollers come in contact with the raised parts of the race and force is put on the bucket line. Usually this will free the object causing the trouble and the machine goes on running. If, however, the trouble remains the removal of the obstacle allows the sprocket to return to running position again.

Galion Automatic Pivotal Axle

The Galion Iron Works and Manufacturing Co., Galion, Ohio, announce the issuance of a patent on July 7, 1928, covering their automatic pivotal rear axle on Galion E-Z Lift Adjustable Leaning Wheel Graders, which is registered as U. S. Patent No. 1679803. It is claimed that this automatic pivotal axle takes care of certain forces on the rear end of the grader that heretofore have tended to cause the machine to slide sidewise in certain kinds of road work. It is also claimed automatically to prevent the ditch wheel from cutting and crowding into the bank and thus spoiling the ditch. The effect of this automatic action is to guide the wheel away from the bank, thus leaving a clean ditch, all of which is accomplished without any effort or attention on the part of the operator. The rear axle is attached to the main frame of the machine by two heavy parallel bars made of special cast steel. When adjusting the position of the rear axle in relation to the main frame, the rear end of the main frame of the machine swings on two heavy wings attached to and being a part of these parallel bars, thereby causing the line of draft to remain practically the same on the rear axle, regardless of the position to which the machine is adjusted.

These parallel bars are so attached and designed that as the machine is adjusted for work they cause the rear axle to be thrown automatically into a skew in the proper direction to overcome the offset pull load caused by the angle at which the blade is working, which, in connection with the leaning wheels to take care of the gravity load of the machine on the incline, entirely eliminates any tendency of side slipping or skidding.

A New Medium-Size Paver

The Ransome Concrete Machinery Company of Dunellen, N. J., has recently produced a new medium-size paver, known as the 13-E. This paver, because of its convenient size, is particularly well adapted to city paving, alleys, smaller country roads, sewer work and other jobs requiring a portable, medium-size mixer.

The New Ransome 13-E has all the features of the larger units. Power is furnished by a 4 cylinder, 30 hp. gasoline engine.

Pierce-Arrow 10-Ton Truck

The Pierce-Arrow Motor Car Company, Buffalo, N. Y., has announced a new heavy-duty truck, the Model R-G. The new model has one of the largest load capacities of any truck on the

RANSOME 13-E PAVER

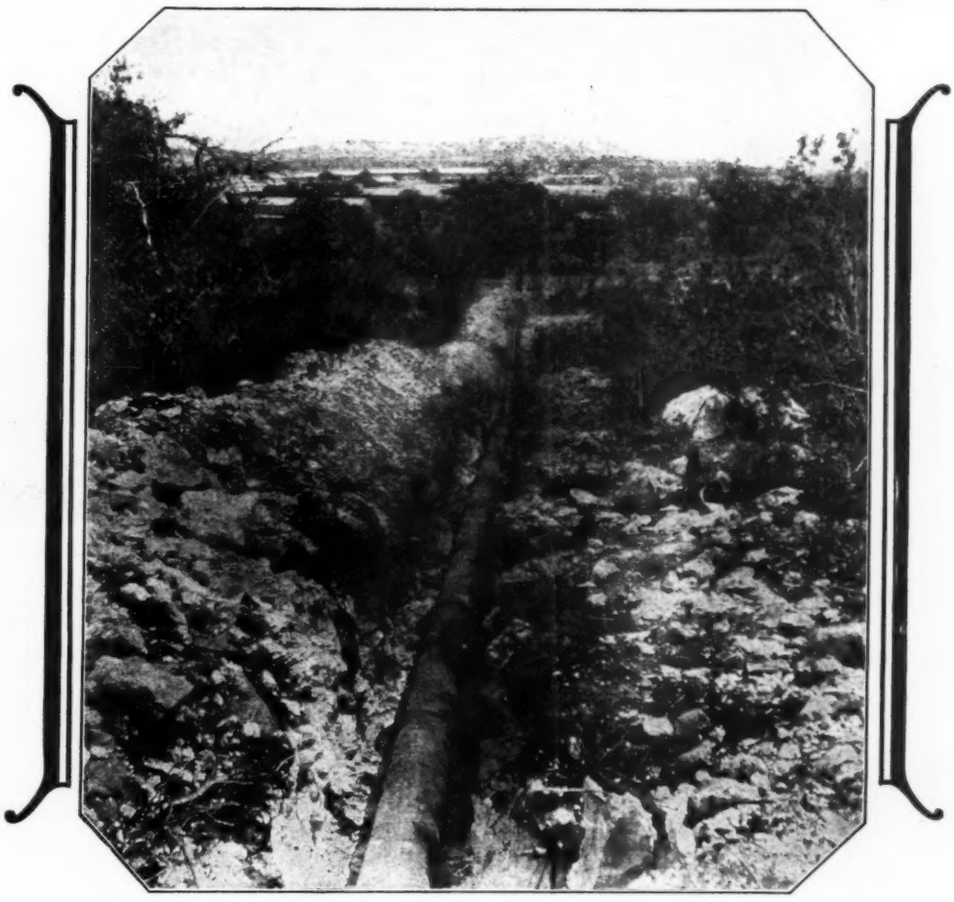
market and its advent will be of interest to operators whose work requires the economical transportation of big loads, in sections where special hauling is permitted. It is expected to fill a distinct need in the sand and gravel industry.

Under the Pierce-Arrow plan of rating the new truck has a vehicle gross weight rating of 36,000 pounds. The chassis will sell for $5,950 at Buffalo. It will be made in two wheelbase lengths, a standard length of 14 feet and a tractor size of 12 feet. Both of these lengths are particularly adapted for maneuvering within narrow confines.

The primary features of the new Model R-G are claimed to be ability to haul very large loads at normal speeds; maximum strength for pulling out of steep declines and an especially sturdy chassis, yielding maximum performance under the most severe operating conditions.

The new Model R-G is the development by Pierce-Arrow truck engineers of a truck for the needs of a group of New York sand and gravel operators who required a heavy, serviceable truck that would haul 10-ton loads with econ-

PIERCE-ARROW 10-TON TRUCK



Eleven Years of Service As Good as New

This 8-inch Universal Pipe water supply line at Leon Springs Training Camp, Remount, Texas, laid eleven years ago, continues to give dependable uninterrupted service.

Nothing to deteriorate, nothing to work loose in these tight, flexible, iron-to-iron joints. Wrenches the only tools.

Let our nearest office show you why Universal Pipe is so much easier—quicker—safer . . . .

UNIVERSAL CAST IRON PIPE

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THE CENTRAL FOUNDRY COMPANY

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omy of operation and the best of performance. A fleet of 31 Model R-G trucks has already been sold to Lanigan Bros., Inc., of New York City.

The V. G. W. rating (vehicle gross weight) of the Model R-G is 36,000 pounds. This with a weight of 11,500 pounds for the 14-foot wheelbase dump chassis, complete with cab and filled with gas, water, oil, tools and power take-off on the transmission, leaves a balance of 24,500 pounds for pay load and body. If an allowance of 4,500 pounds be set aside for dump body and hoist, this leaves 20,000 pounds for pay load which may be carried within the V. G. W. rating or 10 tons.

The Pierce-Arrow dual-valve, dual-ignition engine of the Model R-G truck generates close to 70 horse power. It is four cylinder, with a 4½-inch bore and 6¾-inch stroke, with semi-steel cylinders cast en bloc. Among the notable mechanical features are forced feed lubrication, automatically regulated Pierce-Arrow Stromberg carburetors and oil purifier.

A new feature of this chassis is the fact that the foot pedal operates by power both the brakes on the rear axle and on the propellor shaft. The hand brake

CONNERY OIL BURNING KETTLE

operates on the rear wheels in the usual manner, but its use will be limited to holding the truck when parked, because of the perfect operation and strength of the foot brakes.

Universal Truck Mounted Skimmer Scoop

The Universal Crane Co., Cleveland, O., has brought out a skimmer scoop which is readily adaptable to any standard Universal Crane, being interchangeable with the other Universal attachments, such as clamshell or dragline or the back digger attachment. This is claimed to be the only such attachment now built for use on motor truck mounted equipment.

The skimmer boom is a built-up, riveted, all-steel box section with a double track along the bottom side, on which runs a carriage of four rollers supporting the skimmer bucket. The skimmer bucket is equipped with a special cutting edge and can be used with or without teeth, depending on the character of the material being graded. The cutting stroke of the bucket is approximately 12 feet and the maximum cutting radius is approximately 23 feet. The control of the boom permits making cuts from 6 inches to 2 feet deep with a very accurate control.

The bucket is of a bottom dump type, with a trip controlled by a lever just to the right of the operator. The bucket is returned to a digging position by gravity. A special spring mounted stop is provided at the back end of the runway to take up this impact, thus saving the boom and bucket from undue shock.

The operating speeds are exceptionally fast, the bucket speed being 70 feet per minute on two part line and the boom hoist being controlled by the shell drum with a speed of 150 feet per minute. To aid in the speedy and constant boom dericking required for skimmer work a special oiling device is provided for the boom feet sockets. The operator controls all operations from his seat located at the front of the rotating platform, with an unobstructed view of his work at all times. There are only two hand levers and two foot pedals to control all the major operations.

Simplex Pipe Pushing Jack

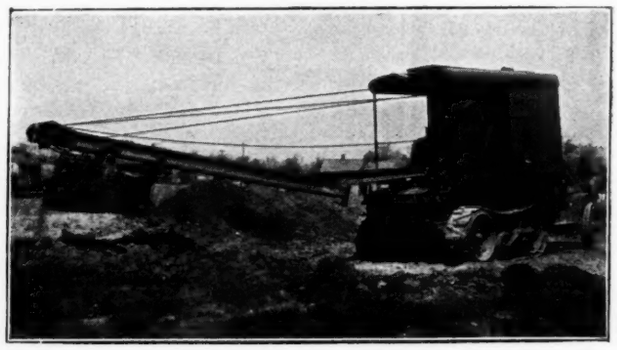
Templeton, Kenly & Co., Ltd., Chicago, Ill., have developed the Simplex pipe pushing jack, which is especially designed to push pipes under paved streets, alleys, lawns, tracks, etc. The pipe is gripped by jaws in the center of the jack and one or two men operating each of the two levers push the pipe through the ground accurately.

These jacks are built in two sizes, the No. 332 for pushing pipe ¾″ to 2″ in diameter and the No. 334 for pushing pipe of 2″ to 4″ in diameter, a feature being that each size of pipe requires a set of jaws to conform to the size of pipe. By this method the crushing or distorting of the pipe is avoided.

The average time required to push a 3-inch pipe through 25 inches of solid soil is said to be between 5 and 6 minutes, using 2 men on each of the 2 levers, or approximately 23 man minutes, which time also included resetting the pushing or traveling portion of the jack.

Good Roads Concrete Carrier

The Good Roads Machinery Co., Kennett Square, Pa., has brought out a carrier for handling ready-mixed concrete. This carrier is essentially the one



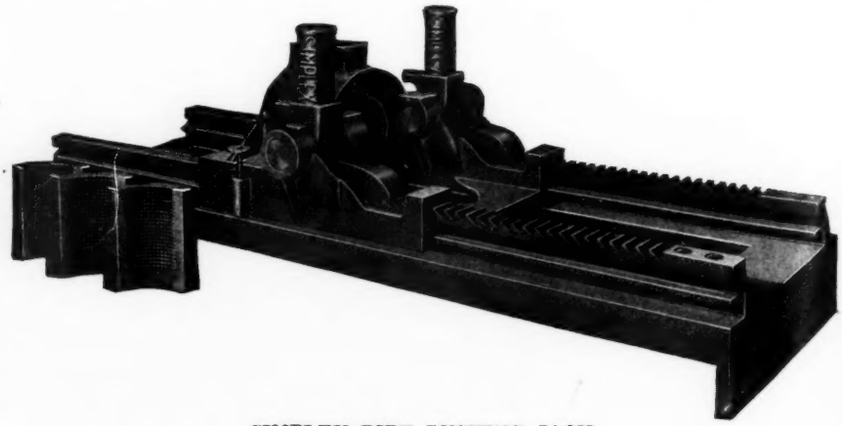
UNIVERSAL SKIMMER SCOOP

described in the March, 1928, issue of Public Works. This equipment is now manufactured in the plant of the Good Roads Machinery Co. It is claimed that with the use of this equipment, a premixed batch can be transported to any place where the time required for delivery is not in excess of 3 hours. Up to this period the batch can be held at the exact consistency at which it came from the mixer.

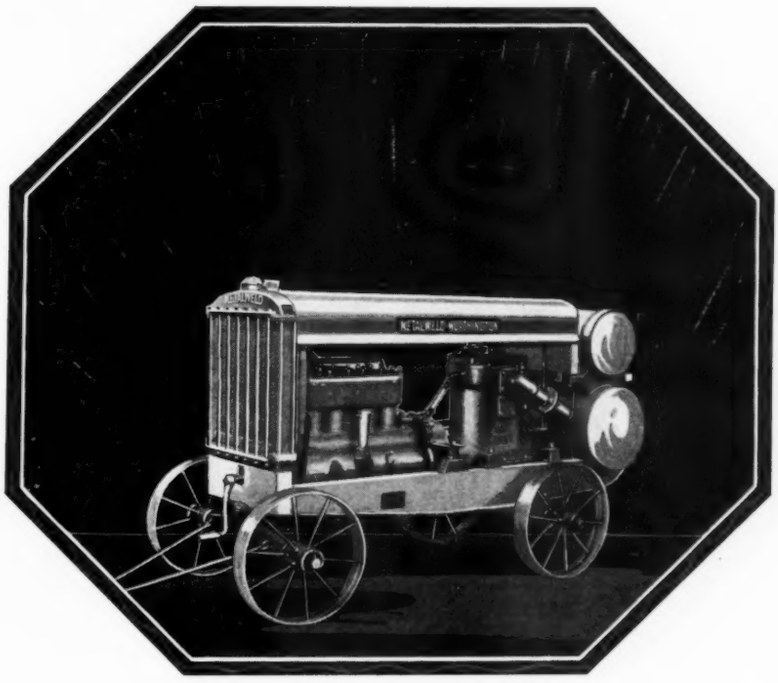
Connery B-2 Oil Burning Kettle

Connery & Co., Inc., Philadelphia, Pa., have brought out a new heavy duty oil burning kettle, the B-2, which was designed for road contractors and municipalities who require hot tar or asphalt in large quantities, and need it in a hurry. This kettle is made in three capacities, 300, 400 and 550 gallons, and will melt a batch of tar or asphalt in considerably less time than it can be done by coal or wood.

The inside kettle sets entirely within the furnace shell and the intense heat from the two oil burners circulates completely around it. It is made of ¼″ firebox steel and is equipped with large



SIMPLEX PIPE PUSHING JACK



The Quality Machine of the Portable Air Compressor Field

There are no two ways about it: the M-W "Air King" was designed with but one end in view—to do *more work* at lower cost. It is the outstanding value in the field—a record winner among Portable Air Compressors!

Built by engineers who have specialized only in Air Compressor design, the M-W "Air King" repeatedly and unfailingly does a better day's work than you would normally demand from it. Under any and all operating conditions—for road building, railway maintenance, paving breaking, trench digging, and similar work—it has won its present enviable position on sheer merit alone.

There is an M-W to exactly fill your needs—in 110, 210, 280 and 330 cu. ft. sizes—mounted to meet your specific requirements.

Illustrated detailed catalog mailed on request.

METALWELD, Inc.

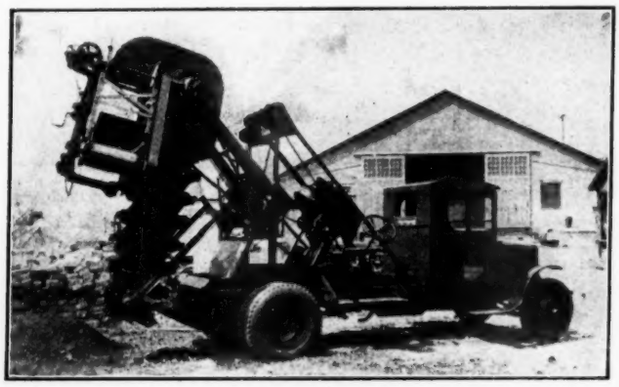
26th and Hunting Park Ave., Philadelphia, Pa.

(Dealers in all principal cities)

Metalweld-Worthington *Portable Air Compressors*

strainer which prevents the material from clogging the faucet. All seams are double electrically welded and non-leakable.

All wheels are roller bearing equipped; steel wheels are standard equipment; rubber tired wheels and heat guards are extra. This kettle can also be equipped with the following at extra cost: barrel hoist; Connery's hand spraying attachment; barrel warming hood.



BARBER-GREENE DITCHER ON SCHACHT TRUCK

Butler All-Steel Scale

The Butler Bin Co., Waukesha, Wisc., has brought out an all-steel scale for attachment to the Butler weighing hopper for the accurate proportioning of aggregate. It is claimed that this new scale has a number of advantageous features, which include a high degree of accuracy, due to unusual rigidity and elimination of variations due to flexure; the necessity for only minor field adjustments; durability, because of the elimination of castings and the use of steel in all parts; easy installation, since each pair of knife edges lie in a horizontal plane, and the task of leveling them is simplified, while a spirit level is all that is necessary for installation; all knife edges are interchangeable, and when long service has dulled their edges, they may be driven out, and new ones put in.

Schacht Truck with Barber-Greene Trencher

The Le Blond-Schacht Truck Co., Cincinnati, O., and Barber-Greene Co., Aurora, Ill., have collaborated in the installation of a Barber-Greene trench-digger on a 3½-ton Schacht truck. This was built for O'Connell & Sweeney, general contractors, of Cincinnati, O., who have a two-year contract to make all openings in city streets for water connections. This work requires a digging outfit with a high degree of mobility.

A special transmission with an exceedingly low gear reduction permits a digging speed of 1½ ft. per minute. The maximum road speed when traveling from one job to another is approximately 18 miles per hour. One operator can handle and control the complete outfit. A seat is provided on the right-hand side of the chassis, from which the operation of the digger is controlled, as well as the forward movement of the chassis. An auxiliary steering gear is also provided at the side to control forward movement of the truck when digging.

The chassis is of 3½-ton capacity with a wheelbase of 172 in. It is equipped with a heavy engine governed to 1,000 R. P. M. at which speed it develops 60 horsepower; 36x8 pneumatic tires (duals rear) provide the necessary traction when operating in soft places and also permit faster running speed when going from job to job.

In view of the exceptionally low gear reduction with which the chassis is provided in order to make possible the slow speed of 1½ ft. per minute when the digger is in operation, it has been necessary to install a safety joint in the drive shaft which will shear off if for any reason the rear wheels become obstructed by an immovable object, thereby preventing the possibility of transmitting a destructive force to the differential gears.

The utility of this outfit has been given a practical test by O'Connell & Sweeney. As many as 43 openings have been made in a single day, yet with this outfit the services of only one man are required.

Pneumatic Snow Plow Lifting Device

The Good Roads Machinery Co., Kennett Square, Pa., in collaboration with the White Motor Truck Company and the Westinghouse Air Brake Company, has developed and placed on the market a pneumatic lift for snow plows attached to trucks and buses.

Prior to this development, it is claimed, a second operator has been necessary on the driver's seat for the sole purpose of operating the manual lift device of a snow plow. This entailed considerable added expense for comparatively intermittent and unskilled service, but was absolutely necessary, as it was out of the question to add this to the duties of the driver. This particularly applied to buses and made the problem especially difficult, because no space was available for the plow operator.

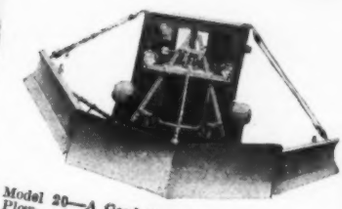
The lift is operated by a vertical Westinghouse air cylinder, attached to the "A" frame clamped to the chassis in front of the radiator. It is easily substituted for the prevalent hand operated hoist on existing plows. The lift chain is automatically locked when the air is shut off, but can be quickly released by pulling the trip rope.

Trucks and buses equipped with air brakes require no further attachments than the air cylinder and lock. Those not equipped with air brakes can, with a small expenditure, attach a Westinghouse Air Compressor to the timing gear box on the motor and the necessary air tank to the chassis. Tests show the time required to raise a plow with this device is counted in seconds instead of minutes.

It is common practice to leave the "A" frame on the front of the truck or bus during the snow season, as only a few minutes are then required for hooking on the plow when needed. However, the "A" frame is also readily removed when desired. This Good Roads-Westinghouse unit is suitable for any type of snow plow,—one-way, V, shovel nose, etc.

GOOD ROADS PNEUMATIC SNOW PLOW LIFTER

Good Roads MACHINERY



Model 20—A Good Roads Champion V-Type Plow—with or without side wings, for trucks up to 5 tons. A favorite with transportation and bus companies, and particularly commending itself to bus owners when used in connection with Good Roads-Westinghouse Pneumatic Lifting Device. One-man control.

Model 21-B Good Roads Champion High Speed Highway Plow. For 3½ ton trucks and heavier. The most efficient high speed highway plow, showing one wing drawn in, other extended. Max. spread 16 ft. Min. clearance, both wings drawn in, 11 ft.

Model 23 Good Roads Champion Cross-Walk Plow and Back Filler. For piling, sewering, and for use at pavement intersections.

Good Roads Champion Snow Plow—Model 25. Reversible blade type — extra high mold-board (36")—for trucks up to 5 tons. Especially constructed to meet local demands for a blade plow with extra high mold-board.

AMERICAN ROAD BUILDERS' ASSOCIATION
1929 CONVENTION and ROAD SHOW JANUARY 14 TO 18 INCLUSIVE CLEVELAND OHIO

THE GOOD ROADS MACHINERY COMPANY
KENNETT SQUARE, PA.

Pittsburgh, Pa.....1523 Oliver Bldg.
New York, N. Y.....50 Church St.
Albany, N. Y.....36 State St.
Buffalo, N. Y....733 Ellicott Square Bldg.

Branches:

Watertown, Mass.....36 Pleasant St.
Portland, Ore.....3rd and Hawthorne Sts.
Chicago, Ill.....49th and Halsted Sts.
Philadelphia, Pa.
420 Commercial Trust Bldg.

Improved Trimo Pipe Wrench

The Trimont Manufacturing Company, Inc., Roxbury, (Boston), Mass., announces a new Trimo pipe wrench. Although the contour of the frame has been slightly extended, the appearance of the new wrench remains practically unchanged, and the parts of the old and new wrenches are interchangeable throughout.

TRIMO WRENCH

An entirely new and scientifically developed method of heat treating gives to the handle far greater strength and toughness. The swinging steel frame, though not materially changed in appearance, has been strengthened to such a degree that breakage is virtually out of the question, even under the most trying conditions.

As a further safeguard, overlapping side lugs, an integral part of the handle, brace the frame effectively against lateral distortion or spreading. The design of these reinforcing lugs furnishes a rugged safety feature without in any way hampering the action of the frame or adding to the bulk of the wrench.

The replaceable insert lower jaw and the popular nut-guards which protect the adjustment are economy and convenience features of the new, improved Trimo.

Stover Power Unit

The Stover Mfg. & Engineering Co., Freeport, Ill., have recently developed a light-weight, heavy duty vertical gasoline power unit. This engine is single cylinder, four cycle, hopper or radiator cooled, and develops 2 to 3 horse-power at 1000 to 1500 r.p.m. The construction throughout is in accordance with latest practice, and both hot spot and air cleaner are provided. Power can be delivered from the cam shaft when desired; this operates at about half the speed of the crank shaft and provides a simple speed reduction device.

For general use, the Stover engine is completely enclosed in a specially designed housing so that the unit can be placed in a very small space. The housing is of heavy gauge black metal which is painted. A removable door on either side allows easy acess to the engine.

Stary Automatic Siphon

F. Stary & Sons, Cedar Rapids, Ia., manufacture a line of automatic siphons, which are claimed to be reliable and durable. The Stary Improved Siphon consists only of plain castings with no machine work. The parts are the discharge limb or trap, the cap, and the intaking limb or bell. The trap rests on the floor of the flush tank with the outlet opening into the sewer; the cap is supported within the trap by four webs cast integral therewith; and the bell rests on the cap and is kept in position by webs cast therein. The parts are of soft gray iron. There are no joints to maintain, nothing to adjust and no moving parts.

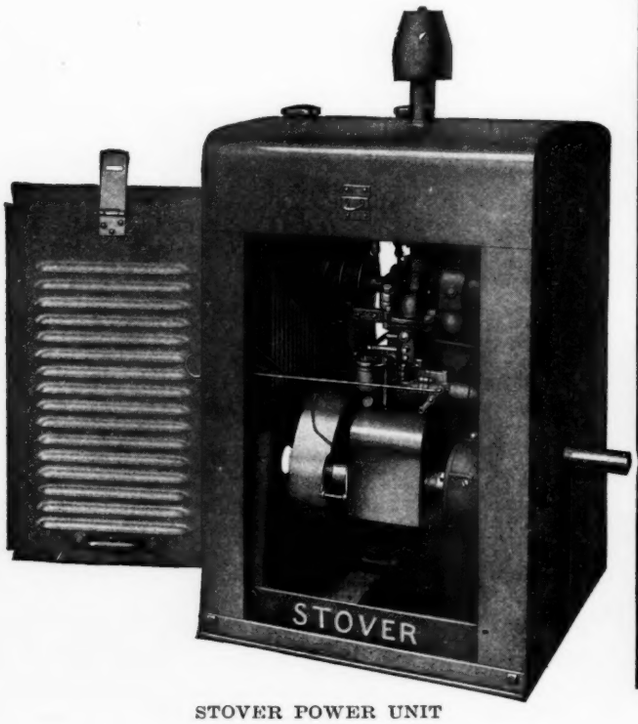
These siphons are made in both shallow and standard styles and in 4, 5 and 6-in. sizes, with drawing depths from 14 to 30 inches, and discharging depths up to 35 inches.

Rightway Pavement Repair Unit

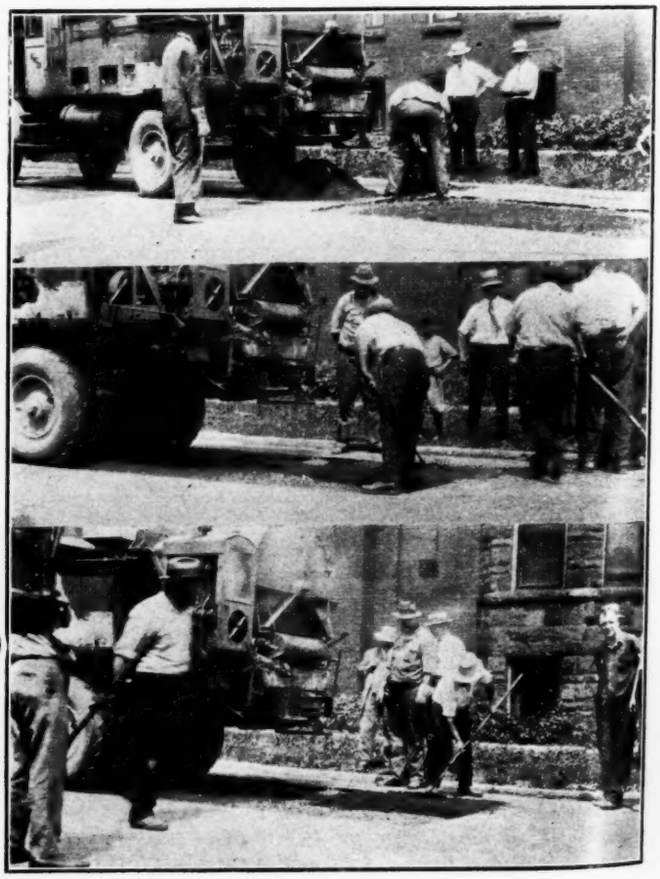
The Rightway Corporation, Chicago, Ill., manufactures a unit particularly suited for use in maintenance and repair work on streets and pavements. It is portable and demountable, self-contained, and can be mounted on any truck or trailer, providing complete equipment for rapid and economical patching and repair work.

The equipment carried by this unit includes a gas heated oscillating oven for heating and drying sand and stone; a power operated crane for handling all material; bins for crushed stone, sand and cement or stone dust, heated when necessary; gas heated asphalt tank; gas heated tool and implement compartments; a power operated mixer for preparing the batches; and a self-contained power plant and mechanism for complete operation. All controls for operation are at the rear and right hand corner, so that workmen are not exposed to injury from vehicles and there is a minimum of obstruction to traffic.

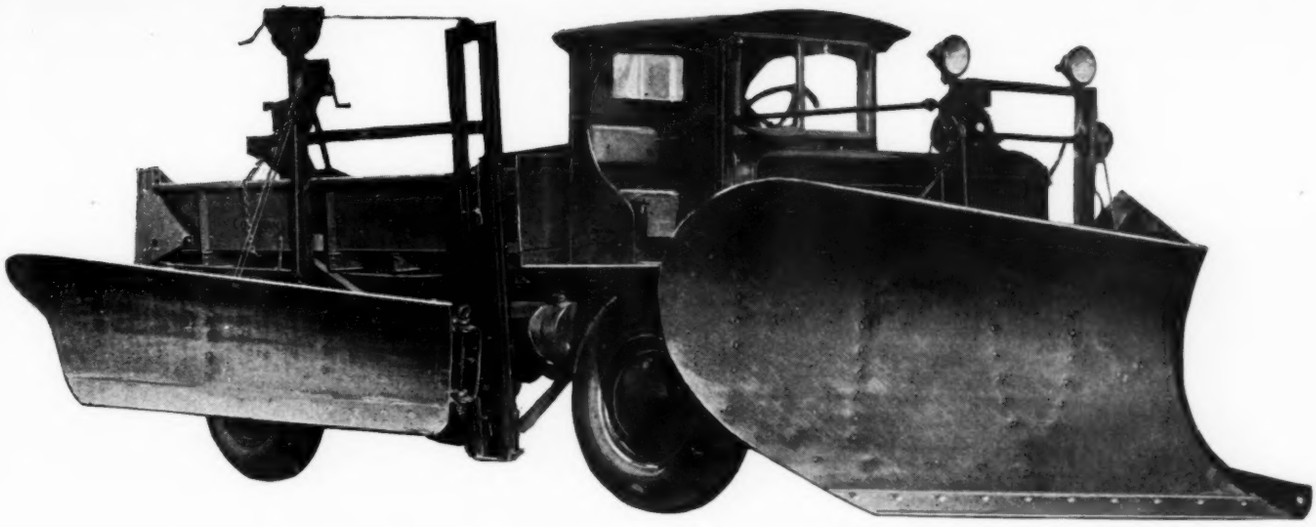
The stone and sand bins have a capacity of one yard each, and are easily filled; the dust bin capacity is 10 cubic feet; and the asphalt capacity 150 gallons. Under normal conditions a batch can be produced every 6 or 7 minutes. Discharge is through a gate in the bottom of the mixer. The great mobility of this unit is of especial advantage and its use often results in a considerable saving on repair work.



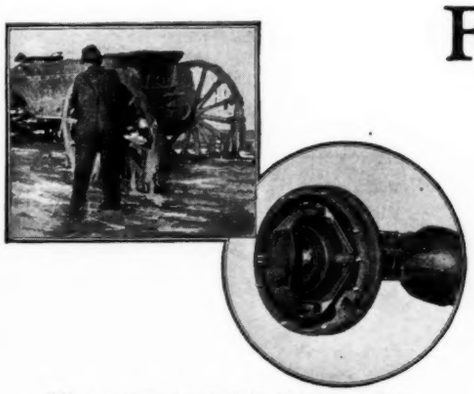
STOVER POWER UNIT



RIGHTWAY PATROL ON REPAIR WORK



SNOW REMOVAL—
and the
FOUR WHEEL DRIVE



Did you ever try to help the team, when the old farm wagon was stuck in the mud? You grabbed the spokes out at the rim of the wheel—not near the hub! This same, simple principle is the secret of Coleman performance. The power is applied to the front wheel out at the felloeband. That's why Coleman Trucks can use 150 to 1 gear ratio in low and still STEER LIKE A TOURING CAR! It's all in the front wheel!

The Coleman 4 Wheel Drive Truck can be easily steered through the deepest drifts and has twice the tractive power to force the plow through the snow. You must have *power in the front wheels* to steer a plow!

Speed in getting from one drift to the next makes the Coleman a more efficient snow fighting machine. A Coleman equals a tractor in draw bar pull—and between drifts runs at thirty miles an hour! The Coleman Truck will clear miles of highway in a minimum of time.

After the snow removal season is over the Coleman can be used for highway repair and maintenance work—hauling road materials—pulling graders and maintainers.

COLEMAN MOTORS CORPORATION

Main Plant	*Branch*	*Eastern Plant*
Littleton, Colorado	Chicago, Illinois	Washington, D. C.

COLEMAN

FOUR WHEEL DRIVE

INDUSTRIAL NOTES

The Erie Steel Construction Company, Erie, Pa., have opened an office at 231 Engineering Building, 205 W. Wacker Drive, Chicago, Illinois. for the sale and services of Erie AggreMeter Plants and Erie Clamshell Buckets. O. H. Watson, is in charge.

Robert Insley has been appointed chief of the recently established aeronautical division of Continental Motors Corporation. Mr. Insley has been for the past eight years assistant chief of the power plant branch, United States Air Corps materials division, Wright Field, Dayton, O.

W. E. Pebworth has been appointed manager of the Dallas Branch, 2301 Griffin St., Dallas, Tex., of the Hersey Mfg. Co., South Boston, Mass.

The Federal Meter Corp., East Orange, N. J., has received an order from the city of Chicago for 11,400 meters.

Contracts have been awarded for construction work on three bridges to be operated by the National Toll Bridge Company, N. Y. The contracts are for the sub-structures of the Hermann Bridge over the Missouri River at Hermann, Missouri, the Madison Bridge over the Ohio River between Madison, Indiana, and Milton, Kentucky, and the Independence Bridge to be erected across the Missouri River near Kansas City. The Hermann Bridge contract was awarded to the Foundation Company of New York. The Madison Bridge substructure will be built by the Vang Construction Company of Pittsburgh. The contract for the Independence Bridge sub-structure has been let to the Union Bridge and Construction Company of Kansas City.

Spencer S. Swasey, of Chicago, has joined the Walter A. Zelnicker Supply Co., of St. Louis, as manager of the Equipment Department. Mr. Swasey was for twelve years with the Geo. D. Whitcomb Co., manufacturers of Whitcomb locomotives, the last six of which he was in charge of sales.

Fred M. Young, president of the Young Radiator Company of Racine, Wisconsin, has accepted a commission as Captain in the Specialist Reserve, Air Corps, U. S. Army. Mr. Young served as aeronautical engineer and pilot with the U. S. Air Service during the late war both in this country and overseas, and his return to the Air Service Reserves marks his continuance of interest in this work with which he has kept in constant contact through his work in the automotive engineering field.

The ratio of the operations to the capacity of the American portland cement industry during the month of September was 91.7 per cent, according to figures released by the Bureau of Mines of the Department of Commerce. During the month 17,856,000 barrels were produced, 20,462,000 barrels were shipped, and there were in stocks on hand at the end of the month 16,722,000 barrels. Production in September, 1928, was 2.0 per cent more, and shipments 3.2 per cent more than in September, 1927. Stocks at the mills were 19.5 per cent higher than a year ago.

The Bingham & Taylor Corporation has taken over the foundry business of the W. P. Taylor Co. James W. Gibney, for 26 years manager, is president and general manager. The office is now located at the plant at Buffalo, N. Y.

Among the recent distributor appointments announced by the Trackson Company, Milwaukee, Wis., are: Wm. Ford & Co. Inc., 15841 Second Blvd., Highland Park, Detroit, Mich.; Industrial Power Co., 2618 Fond du Lac Ave., Milwaukee, Wis.; Industrial Tractor Sales Co. Inc., 180 No. Michigan Ave., Chicago, Ill.; Hooper Equipment Co., 523-527 East Washington St., Indianapolis, Ind.; New England Implement Co., Inc., 19 Jersey St., Boston and 22 Gardner St., Worcester, Mass.; B. Hayman Company, Inc., 118-128 North Los Angeles Street, Los Angeles, Calif.; O. R. Peterson Co., Inc., cor. 21st and Alabama Streets, San Francisco, California; Polson Implement Company, Seattle, Washington; and Zimmerman-Wells-Brown Company, foot of Sheridan Street, Portland, Oregon.

Chemicals
For Water Purification
For Treatment of Sewage

LIQUID CHLORINE

Single Unit Tank Cars | Multi-Unit Tank Cars (1-Ton Containers) | 150-lb. Cylinders

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Sulphate of Alumina

Highest Grades. Manufactured by

Pennsylvania Salt Manufacturing Co.

Executive Offices: Widener Building, Philadelphia

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New York Pittsburgh Chicago St. Louis

Works:
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Wyandotte and Menominee, Michigan